Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

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MARCH 1947

The Proving Ground of Timken Roll Neck Bearings.

Timken Roller Bearings were first applied to mill roll necks more than 20 years ago and, logically, the proving ground of Timken Roll Neck Bearings was The Timken Roller Bearing Company's own steel plant.

Here the pioneer bearings received their initial testing; here, in conjunction with a constant program of engineering and metallurgical research they were developed from the experimental stage to practical, dependable products that could be offered to the steel industry as a sure means of increasing production and reducing costs on rolling mills of all types — hot and cold.

Throughout the many years of development of Timken steel mill bearings, we constantly have anticipated new rolling mill trends and requirements. Thus, some time ago, it became evident that far greater strength and rigidity would be demanded in the rolling mills of the future. We therefore set to work to develop a roll neck bearing which, while possessing all the characteristic advantages of existing roller bearings, would permit the use of larger diameter roll necks and thus greatly reduce roll neck stresses and deflection.

The result was the Timken Balanced Proportion Bearing destined to have far-reaching and revolutionary effects, not only on mill roll necks, but wherever anti-friction bearings are used.

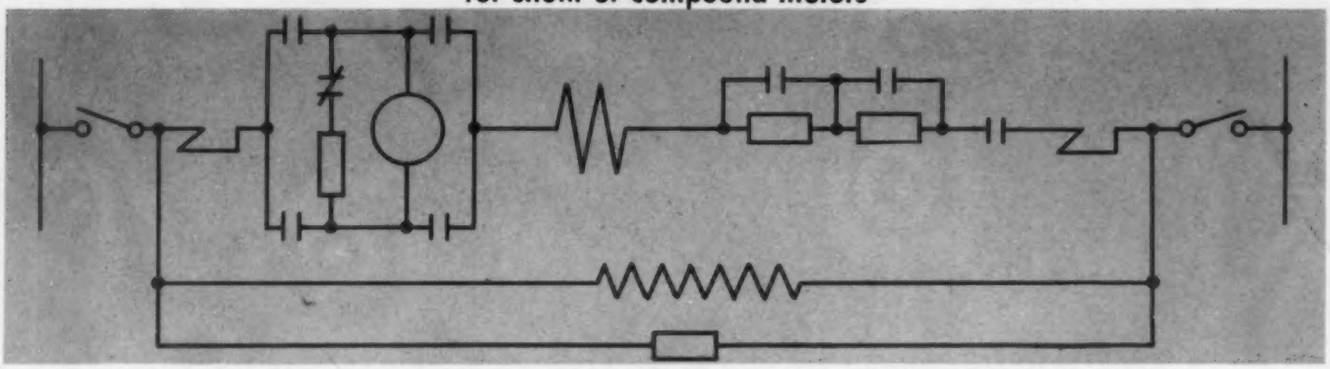
TIMKEN
ROLL NECK BEARINGS

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

What control for what mill equipment? One of a SERIES of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it *the* preferred control for the steel industry.

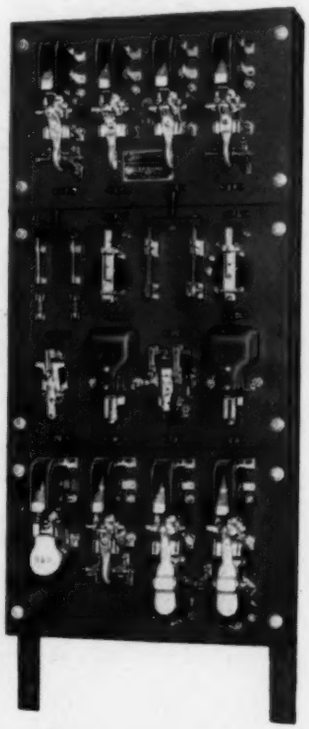
D. C. reversing dynamic braking control

for shunt or compound motors



When you have an installation such as a sheet leveler where load and performance characteristics dictate the use of a reversible shunt or compound motor with dynamic braking . . .

Here . . . . call for Cutler-Hammer Control No. 14017



Engineering features . . Cutler-Hammer Bulletin No. 14017 provides smooth, uniform *L*tl acceleration, simplified dynamic braking and controlled plugging, for quick stop and rapid reversal. Also, when speed control by field weakening is required, Bulletin 14017 provides additional motor protection such as field accelerating, field decelerating, field economizer and field loss relays. It employs dependable constant timing *L*tl contactors which have a coarse and a micrometer adjustment, not affected by dust and dirt. New type 609 overload relay provides inverse time delay for running protection and instantaneous trip for excessive loads.

CONTROL COMPONENTS . . . Every component in Cutler-Hammer Control is built with extreme ruggedness to provide an unusual margin of reserve. Characteristic of C-H Control construction is its simplicity and the absence of light moving contacts and parts, spring adjustments, etc., that commonly cause trouble.

EQUIPMENT . . . Conforming to NEMA standards. Available in ratings to 1800 amperes. In open, enclosed or complete factory assembled ready to wire units. A complete line of control accessories.

TO A DEGREE perhaps not equalled elsewhere, maintenance in the steel industry is costly because of the consequent loss of time and production. To a degree not equalled elsewhere, "steel" wages unceasing warfare on maintenance, placing highest value on durability and dependability of equipment. And it cannot escape the eye of shrewd production-minded management that it is in "steel" . . . in 50 years of "steel" . . . that Cutler-Hammer equipment has so largely built its world-wide reputation for dependability.

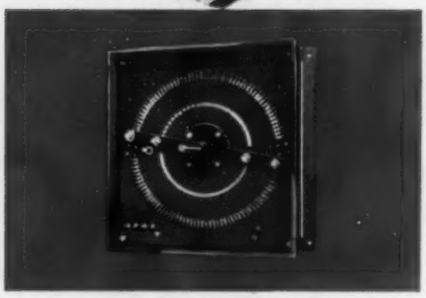
CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Typical Components of Cutler-Hammer Mill Control

Rotating Cam Limit Switch (cover removed)
Wide range heavy duty uses. Wearing parts oversize. Hardened cam face and roller surfaces. Main shaft ball bearings. Easy, accurate driving shaft adjustment in any position.

Pushbutton Station
Wide range of styles including oil-tight construction. No loops in wiring these large rugged terminals. Oversize mushroom type operating buttons. Drip hoods. Guard flanges.



Field Rheostats
50 or 100 speed points. Manual, chain or motor operated. Renewable brass segments. Rugged long life construction. Single step unit type renewable resistors.

Aetna-Standard

FACILITIES

You buy mill equipment from Aetna-Standard for several reasons . . . to help improve your position by increasing production . . . to improve quality of product . . . or to lower operating and maintenance costs.

Engineering and building efficient mill equipment requires diversified machines, keen men and extensive facilities, such as you will find at Aetna-Standard's two plants in Ellwood City, Pa., and Warren, Ohio.

With **Aetna**-Standard, you are doing business with a **big** company, an old, progressive hand, one of the oldest manufacturers of mill equipment . . a company which has built more seamless tube mills and continuous butt weld pipe mills than all others combined . . . the leader in drawbenches and a pioneer in coating equipment.

Remember the name — **Aetna**-Standard.

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO

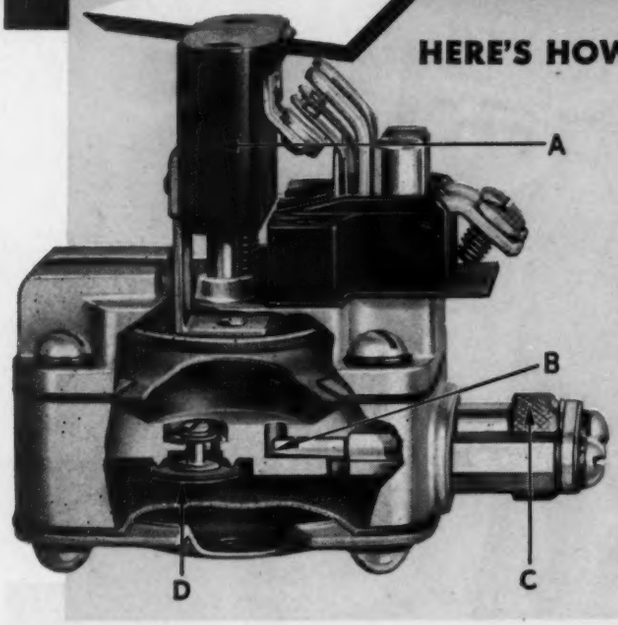
ASSOCIATED COMPANY: HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND

DESIGNERS AND BUILDERS for the Steel, Non-Ferrous and Chemical Industries

PNEUMATIC TIMERS Do It Better

ACCELERATE MILL MOTORS ... and CONTROL AUTOMATIC PROCESSES

HERE'S HOW THEY WORK



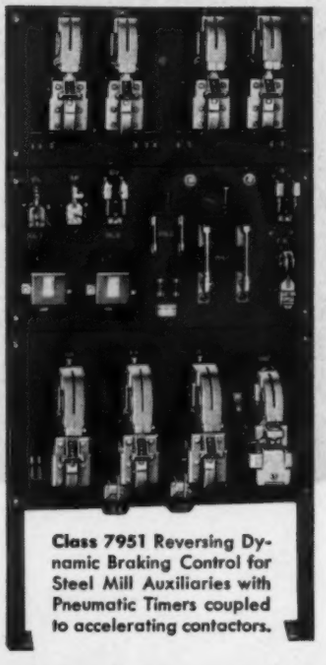
Timing head can be coupled to a contactor or actuated by separate magnet. Contact member (A) is normally pushed down against compression spring. When contact member is released, a rubber diaphragm is flexed upward, drawing air from lower chamber to upper chamber through metering orifice (B). Rotation of knurled wheel (C) advances or withdraws pin to give wide range adjustment. Air returns through valve (D) for instantaneous reset. Lower diaphragm is double layer felt.

Square D's PNEUMATIC TIMERS, a product of over 10 years' experience in many difficult fields of application, offer these proven design and performance features.

- **Extremely accurate**
- **Adjustable over wide range**
- **Unaffected by dust or usual fluctuations in voltage or temperature**
- **Dependable over long periods of severe service**
- **Simple, flexible and easily applied**
- **Attached to contactors or actuated by separate magnet**

• Accurate, fixed timing insures uniform motor acceleration under all conditions of application. Operators are able to obtain closer control by anticipating machine response. Unusually wide range adjustment permits choice of timing period to cover any acceleration requirement.

Processing of steel and associated materials consists of many individual operations performed in timed sequence. (For example—the interval allowed for dumping a blast furnace skip bucket before the hopper rotates.) Pneumatic timers are available for time-delay making or time-delay breaking of a circuit after either energization or de-energization of contactor or separate magnet. Their use in an automatic control circuit simplifies equipment and provides the accuracy and reliability essential to efficient performance.



Class 7951 Reversing Dynamic Braking Control for Steel Mill Auxiliaries with Pneumatic Timers coupled to accelerating contactors.

***Write** for HEAVY DUTY DC MILL CONTROL CATALOG which includes complete information on the Pneumatic Timer and its uses: Square D Company, 4041 North Richards Street, Milwaukee 12, Wis.*

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

Blooming mill and Auxiliary Equipment by

Continental

Engineered for maximum production—longer service—and to your specific job requirement.

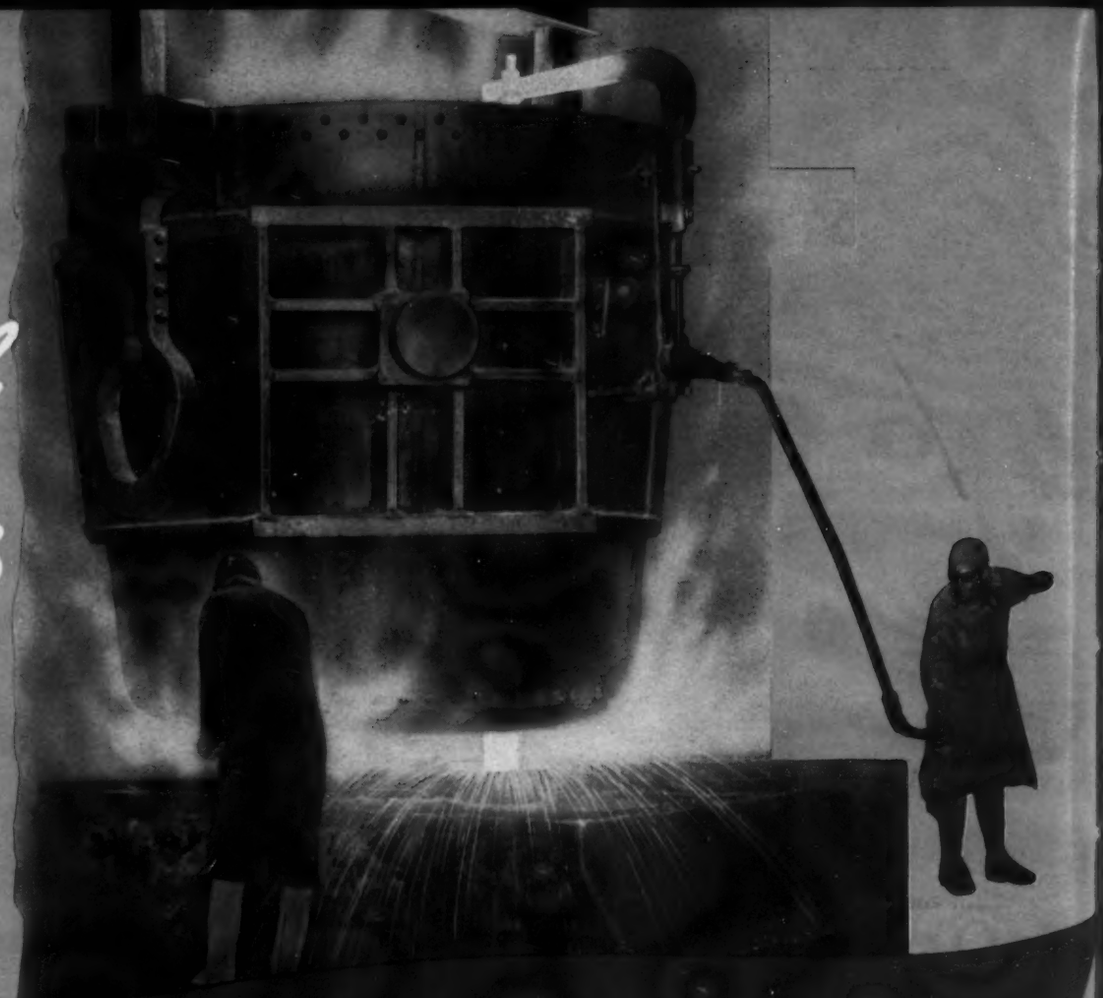
For any ferrous or non-ferrous rolling operation — CONTINENTAL engineers offer world-wide experience in the selection of correctly designed equipment for your specific production problems.

Continental

FOUNDRY & MACHINE CO.

Chicago • Pittsburgh

Plants at: E. Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.



Alloy Steel Castings

are a precision science at . . .

Continental

The most advanced metallurgical practices combined with seasoned foundry skill make alloy steel casting a precision science at CONTINENTAL. You can always depend on CONTINENTAL to produce specification castings that meet your most exacting and rigid requirements for physical properties, true dimensions and uniformity. Put CONTINENTAL'S special ability to work on *your* difficult casting problems.

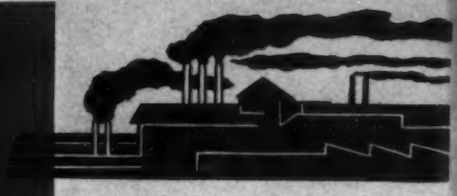
50 POUND TO 250,000 POUND CASTINGS to your exacting specifications

Continental

Continental FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

Plants at: E. Chicago, Ind. · Wheeling, W.Va. · Pittsburgh, Pa.



Industry's Headquarters for
Carbon and Alloy Steel Castings
Rolling Mills and Equipment
Iron and Steel Rolls

cranes built by *Alliance* give you dependable lifting power...

For safe, economical handling of slabs, ingots, hot metal, raw materials and finished products, you can depend on Alliance cranes. Developed by the world's largest builder of the world's largest cranes, they're designed for rugged duty . . . for long, dependable service.

Shown here is a 250-ton push-pull screw-type Stripper. It strips both small end-up ingots and large end-up ingots with hot tops. An added feature for faster handling is the retractable bull nose; with this, no adjustments are necessary when stripping various types or sizes of ingots. A stripper of the type illustrated has recently been built with a maximum capacity of 800 tons with a safety factor of 5.

To give your plant *extra* lifting power—for the development of new cranes or reconversion of your old ones—always rely on Alliance.

THE ALLIANCE MACHINE CO.

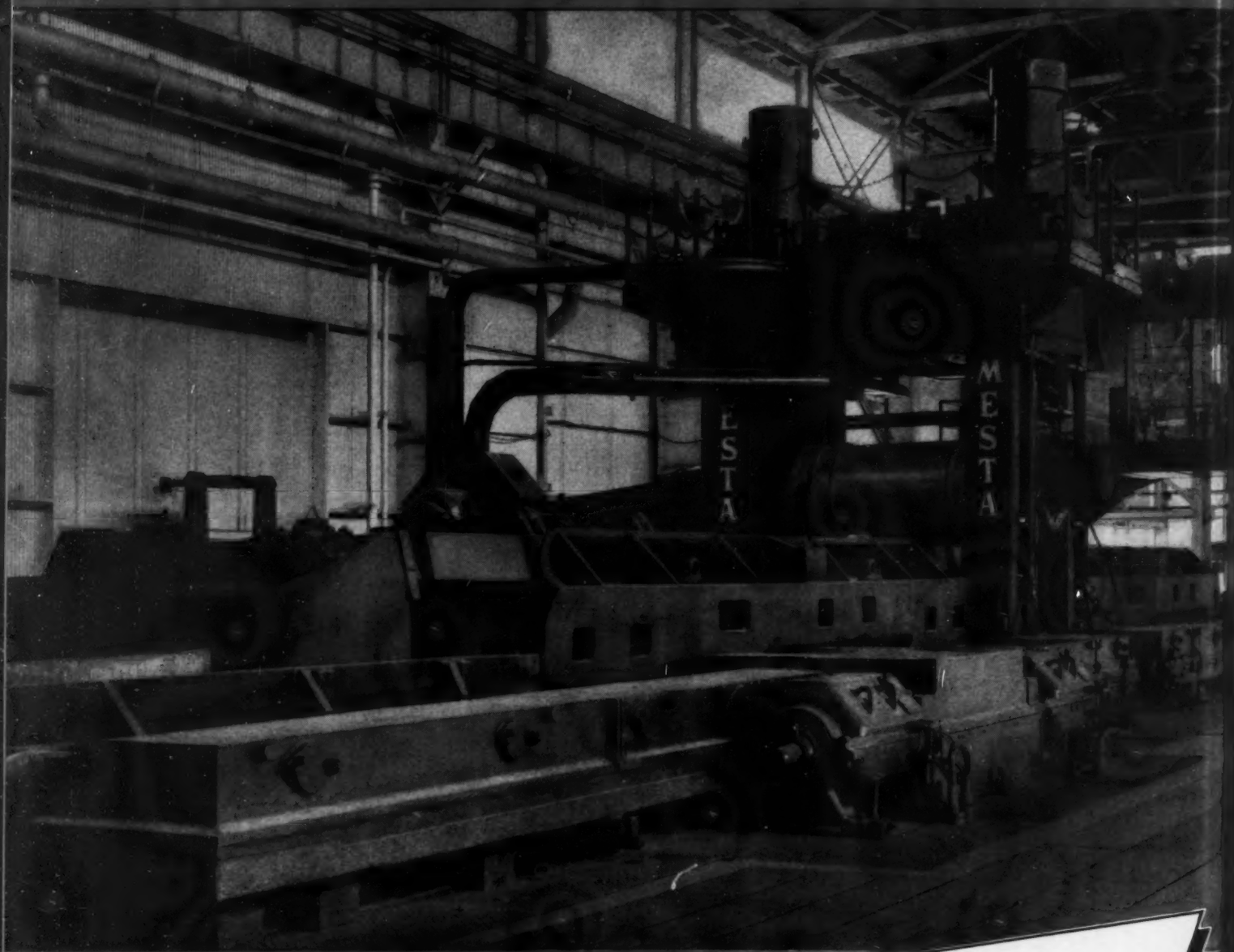
Main Office
ALLIANCE, OHIO

Pittsburgh Office
1622 OLIVER BLDG., PITTSBURGH, PA.

Alliance

LADLE CRANES · GANTRY CRANES
SOAKING PIT CRANES · STRIPPER CRANES
FORGING MANIPULATORS
SLAB AND BILLET CHARGING MACHINES
OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY
STRUCTURAL FABRICATION

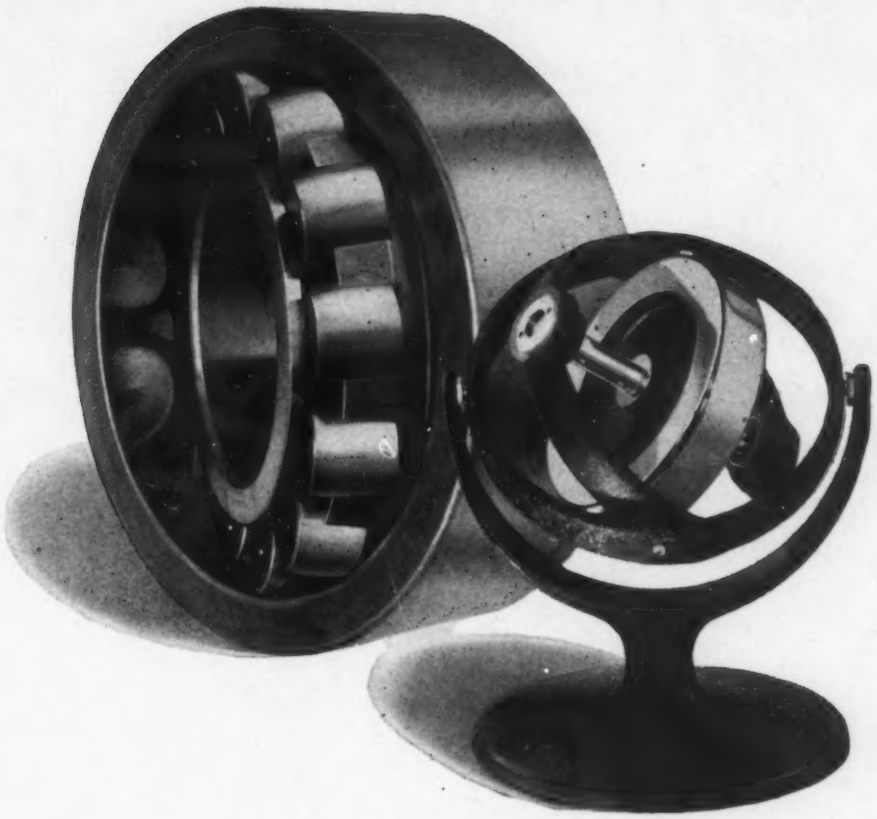
SLABBING-BLOOMING MILLS



Mesta 46" Reversing Slabbing-Blooming Mill, Tables and Manipulators

. . . designed and built by **MESTA**

MESTA MACHINE COMPANY · · · PITTSBURGH, PA.



Operating stability...

is characteristic of both the gyroscopic rotor and the Torrington *Spherical* Roller Bearing. Despite shaft deflection or misalignment, the self-aligning feature of the *Spherical* Roller Bearing

Assures sustained load capacity...

since the full area of bearing contact surface is maintained between rollers and spherical outer race bore. This feature of the *Spherical* Roller Bearing is responsible for its long, efficient and adjustment-free operation in many heavy-duty machines.

Check this and many other advantages of the Torrington *Spherical* Roller Bearing against the requirements of *your* installation. Write today for a copy of our Bulletin #200.

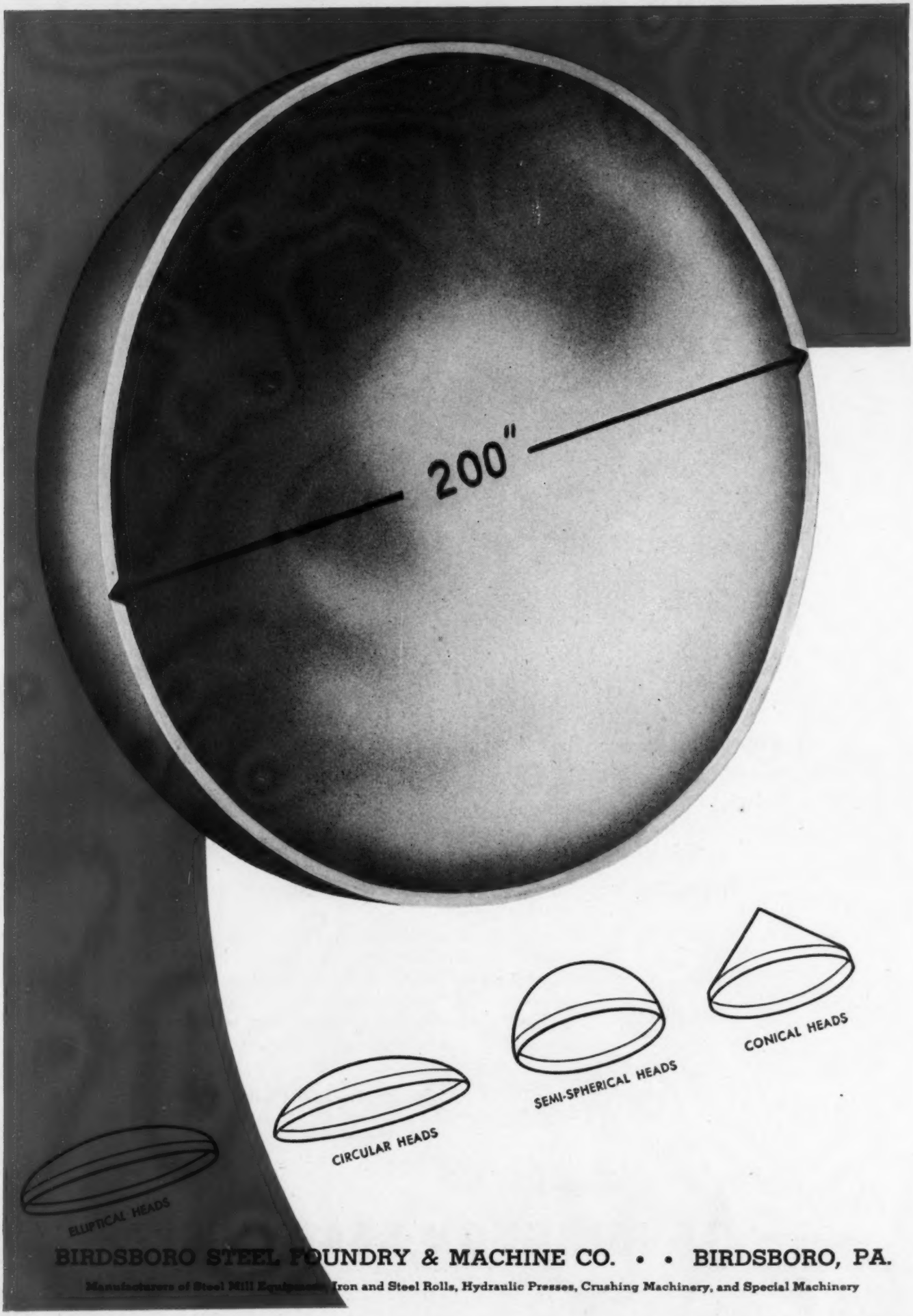
THE TORRINGTON COMPANY

SOUTH BEND 21, IND. TORRINGTON, CONN.

Offices in All Principal Cities

TORRINGTON BEARINGS

NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL



BIRDSBORO STEEL FOUNDRY & MACHINE CO. • • BIRDSBORO, PA.

Manufacturers of Steel Mill Equipment, Iron and Steel Rolls, Hydraulic Presses, Crushing Machinery, and Special Machinery

GIANT SIZE DISHED HEADS

Accurately Spun at Low Cost

ON BIRDSBORO FLANGE SPINNING MACHINES

When you have an "out-size" dishing job, look to Birdsboro Flange Spinning Machines to give you close tolerances and low cost as well as speedy operation. The machine shown is flexible in control and capacity, has a clearance of 17′ between columns and forms flanged and dished heads from plates ¾" to 4" thick.

Designing and building such special purpose machinery is an everyday function here at Birdsboro. Our engineering staff is ready at all times to cooperate in applying their specialized knowledge to give you a practical solution to your heavy equipment problems.

BIRDSBORO

STEEL MILL EQUIPMENT

Dear Friend:
There is not much left on this roll of Okonite Manson Tape but I have been peeling a little off this roll for 25 years and I thought that you might like to hear what happens to Okonite Tape. This roll has been in my possession since 1917.
I have the original tin box and always kept the tape in it and the little bit that is left is still good. I thought you might like to have it for a souvenir.
Manson Tape

MANSON TAPE—STILL GOOD AFTER 25 YEARS

A quarter-century after he purchased this roll of Manson Friction Tape, this customer* returned what little remained on the core for test. Here's the laboratory report:

> "This is the oldest roll of Manson Tape . . . or any friction tape . . . which we have ever examined. This tape still has sufficient adhesion quality to stick and stay put when wrapped as on a joint or splice. There was insufficient tape remaining to conduct all tests. We did, however, make several tests given in ASTM Spec. for Friction Tape D69-28.
>
> "The tensile strength showed 51.2 pounds and 49.3 pounds per inch of width compared with ASTM specified minimum value of 40 pounds per inch of width.
>
> "The tape withstood the ASTM dielectric strength test of 1000 volts without breakdown."

When your electrical department specifies Okonite and Manson Tapes, you're sure to get lasting value. For further information on these tapes, and on how to make a perfect splice with them, send for Bulletin OK-1007. The Okonite Company, Passaic, N. J., makers of insulated wires, cables and splicing tapes.

OKONITE and MANSON TAPES

4841

PLANNING TO HANDLE *Finished Coils?*

— remember to *INCLUDE*

The EC&M TYPE CSM MAGNET

...FOR COLD STRIP COILS

●EC&M Type CSM Magnet (No. 6) lifting two coils weighing 56,600 pounds —*the World's Biggest Lift of Coiled Steel.*

●This EC&M No. 2 Type CSM Magnet is shown in the above illustration, placing a coil on the annealing bottom.

Designed to *lift the coil,* not the hole. No mass of metal over the hole and no concentric pole shoes limiting the flux path in the coil. Instead, this modern magnet combines compactness and small weight with lifting ability distributed *within the coil itself.*

Its advantages for *finished* coil handling are:

1. Magnetic flux concentrated in the coil to be lifted.
2. *Balanced load*—less danger of injury to bottom of coil when depositing coil.
3. Magnet is smaller than other coil handling magnets, weighs less.
4. Magnet does not hide the view of the crane operator.
5. Magnet fits the coil with minimum overhang resulting in increased storage capacity.
6. Less damage to edges of coil because of wide pole shoes which span coil-turns and because weight of magnet is less and is evenly distributed over coil surface.

For handling *Raw Coils,* other EC&M Magnets are available. Information on request.

E C & M

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET

CLEVELAND 4, OHIO

Heat-treat foreman inspects temperature record of Micromax Pyrometer during the heat-treatment of forgings. Penna. Forge Corp., Philadelphia, Pennsylvania.

FORGINGS, FOR INSTANCE- - -

These catalogs describe Micromax temperature recording and are available on request. Or, if you prefer, an L & N engineer will call with further information.

Need This AUTOMATIC Protection During Heat-Treatment

In the busy Control Room shown above the Pennsylvania Forge Corporation is using Micromax Pyrometers to regulate the heat-treating temperatures of forgings through cycles which may be several days long.

During such cycles any potentiometer pyrometer should be "standardized" at regular intervals, because its operating cells change in voltage as they are used. Standardizing corrects the effect of these changes, and thereby preserves the full accuracy and dependability which are the main reasons for potentiometer type pyrometers.

This standardizing can of course be done by a man, but in Micromax strip-chart instruments gears do it — automatically. And these gears operate every 45 minutes — much oftener than a man would make the correction; oftener even than is necessary if the operating cells are at their longest level of performance. But very new cells, or very old ones, or ones which have been frozen, baked or otherwise damaged, have no long level. So, Micromax takes no chances. It guards its own accuracy at all times and thus helps to maintain the quality of heat-treatment.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA. 44, PA.

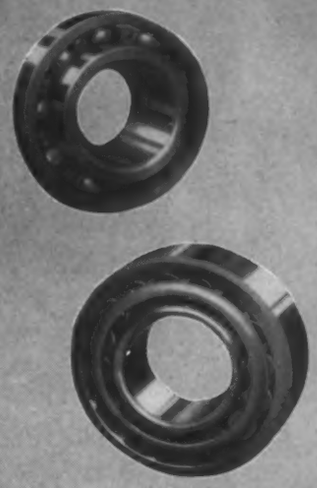
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad N-33-620(11)

BALL AND ROLLER BEARINGS

BY LINK-BELT



● In countless applications, Link-Belt Ball and Roller Bearings are protecting costly equipment, by their well-known ability to take either radial or thrust loads, or a combination of both, and their self-aligning features.

Available in unmounted sizes or mounted units, pillow blocks, cartridge, flanged, hanger and take-up units. Send for catalogs Nos. 2094 and 2095.

ENGINEERED AND BUILT TO HIGHEST STANDARDS BY

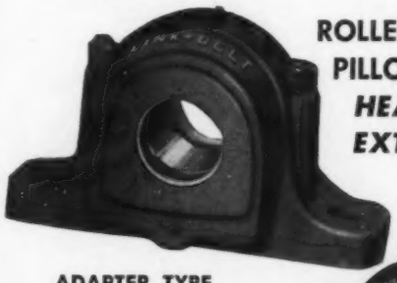
LINK-BELT COMPANY

THE LEADING MANUFACTURER OF CONVEYING AND MECHANICAL POWER TRANSMISSION MACHINERY

Chicago 9, Indianapolis 6, Philadelphia 40, New York 7, Atlanta, Dallas 1, Houston 2, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8.

Offices, Factory Branch Stores and Distributors in Principal Cities.

10,544



ROLLER BEARING PILLOW BLOCKS
HEAVY AND EXTRA HEAVY

ADAPTER TYPE
HEAVY SERIES 6800
EXTRA HEAVY SERIES 6900

•

PRESS FIT ON SHAFT
HEAVY SERIES 7800
EXTRA HEAVY SERIES 7900

BALL BEARINGS
LIGHT SERIES 200

PILLOW BLOCK-SOLID HOUSING

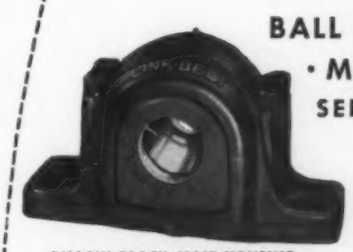
PILLOW BLOCK-SPLIT HOUSING

FLANGE UNIT

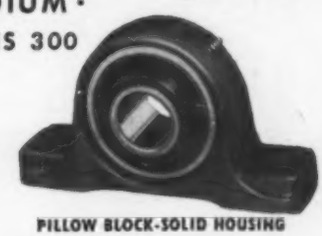
TAKE-UP UNIT

HANGER UNIT

BALL BEARINGS
· MEDIUM ·
SERIES 300



PILLOW BLOCK-SPLIT HOUSING

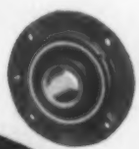


PILLOW BLOCK-SOLID HOUSING

FLANGE UNIT

TAKE-UP UNIT

CARTRIDGE UNIT



FLANGE CARTRIDGE UNIT

LINK-BELT
BALL AND ROLLER BEARINGS

ROLLING TECHNIQUE . . .

BLOOMING MILL ROLLS

MODERN blooming mills are usually of the two-high reversing type. The rolls may be as large as 54" but average about 40". PITTSBURGH ROLLS for the blooming mill, whether of plain carbon steel for extreme strength, or of Phoenix "A" Alloy Steel where unusual wearing qualities are desired, will produce blooms, billets, and slabs at LESS COST PER TON OF STEEL ROLLED.

PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.

The illustrations show how the cross section of the piece changes as it passes from ingot to billet.

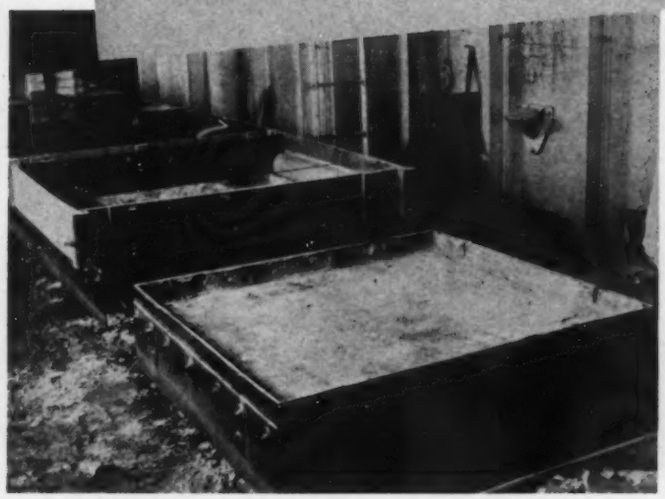
PITTSBURGH ROLLS

Smooth, Level Tops for Annealing Furnace Cars Easily Built with

REFRACTORY CONCRETE

* * *

Jointless tops, cast in place, simplify loading, reduce maintenance



1. Placing Refractory Concrete on cars for continuous annealer

2. Finished tops loaded with annealing boxes

CONSTRUCTION. Cars are fitted with simple side-forms, as shown in picture No. 1. Refractory Concrete, made with LUMNITE and crushed firebrick, is cast in place to form a monolithic slab. Forms are stripped and tops are ready for loading within 24 hours after placing the Refractory Concrete.

SERVICE. The flat, unbroken slab of Refractory Concrete permits easy setting of heavy forgings, castings or annealing boxes—as in picture No. 2. Because of the one-piece construction, there are no small units to tear out and leave a ragged, rough surface—no open joints to fill with scale and dirt.

Repeated heating and cooling does not disturb the Refractory Concrete, which is exceptionally resistant to spalling. The mix of LUMNITE and refractory aggregate is designed according to temperature and insulation requirements.

For detailed information on methods of using Refractory Concrete in annealing furnaces, write: LUMNITE DIVISION, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

LUMNITE A UNIVERSAL ATLAS PRODUCT **FOR REFRACTORY CONCRETE**

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel—Sunday Evenings—ABC Network*

the BILLETEER cuts conditioning costs 4 ways

$ LOWER LABOR COSTS

One semi-skilled operator, using a Billeteer, can do the work of ten hand chippers —radically reducing labor cost and releasing man-power for less-killing, actually-productive work.

$ SUSTAINED EFFICIENCY

Operation of the Billeteer imposes no strains on the worker. Quality and quantity of output never suffer from fatigue, grogginess, jitters, illness or "off" days.

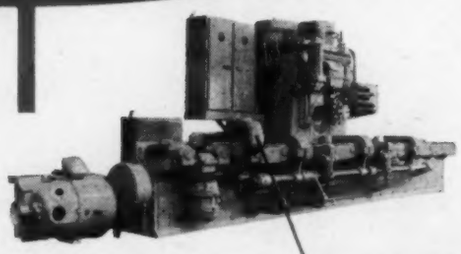
$ VALUABLE SCRAP RECOVERY

The Billeteer does not "burn up" hard-to-get scrap. Every chip can be saved . . . clean . . . classified according to analysis . . . ready for the charging box. In some mills, each Billeteer saves as much as 1½ tons of scrap a day.

$ BILLET SALVAGE

Because of the low operating cost, the Billeteer can be used to salvage billets so badly seamed that it would be impractical to attempt to save them without the Billeteer.

LET US SHOW YOU how much the Billeteer can save in your Billetshed operations.



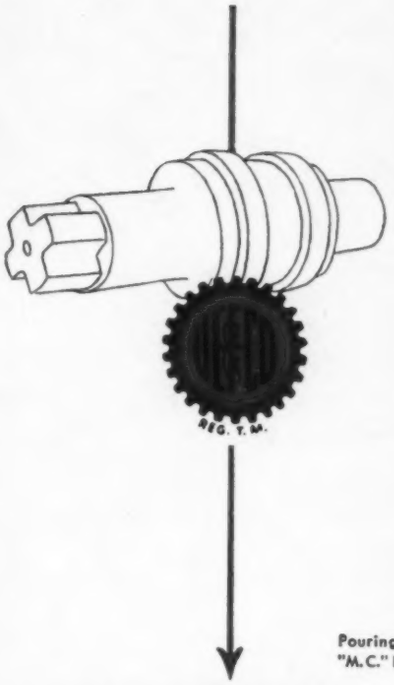
Engineered

FOR LOWER OPERATING COSTS

BONNOT

THE BONNOT COMPANY • builders of the BILLETEER • CANTON 2, OHIO

• Bonnot Billet Inspection Tables • Charging Tables • Cold Saws Grinding Pans • Clay Mixers • Clay Feeders, Etc. •



Pouring an "M.C." ROLL

UNITED... *Announces* the NEW * "M.C." ROLL

(Identified by Dark Blue Wabbler)

One of the most difficult to obtain and yet highly desired specifications demanded of a maker is to produce a roll with sufficient wear resistant depth for deep section rolling, and for finishing and semi-finishing work on bar mills and rod mills.

UNITED has satisfied this demand by the development of the "M.C." Roll, a truly *Master Chilled* Roll with a chill that *shows no mottle* at any reasonable working depth. Combined with the desired feature of depth, "M.C." Rolls, through special alloying and a carefully controlled melting practice, give the user added assurance of strength and long service life.

"M.C." Rolls are made in one grade only. The hardness range is from 60 to 65, and *this hardness structure is maintained through the entire working depth.*

"M.C." Rolls are a proven product—an answer to the demand for rolls with deep chilled structure and strength, especially in the small and medium diameter range.

Specific recommendations for their application will be gladly furnished at your request.

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

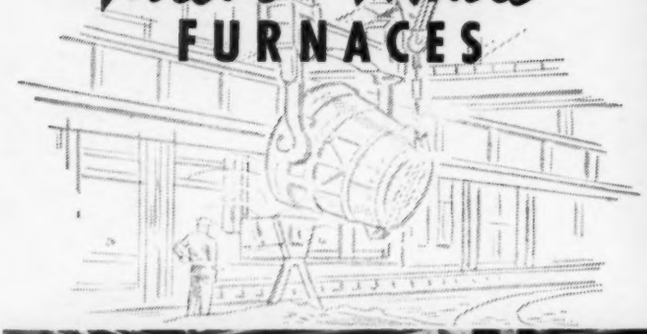
Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P.Q., Canada

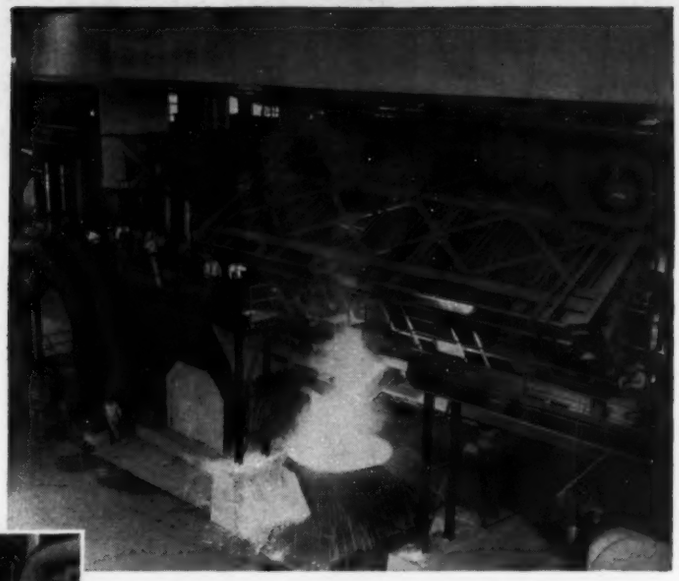
* *One of A Complete Line of 16 UNITED ROLLS Individually Color-Branded for Type Designation*

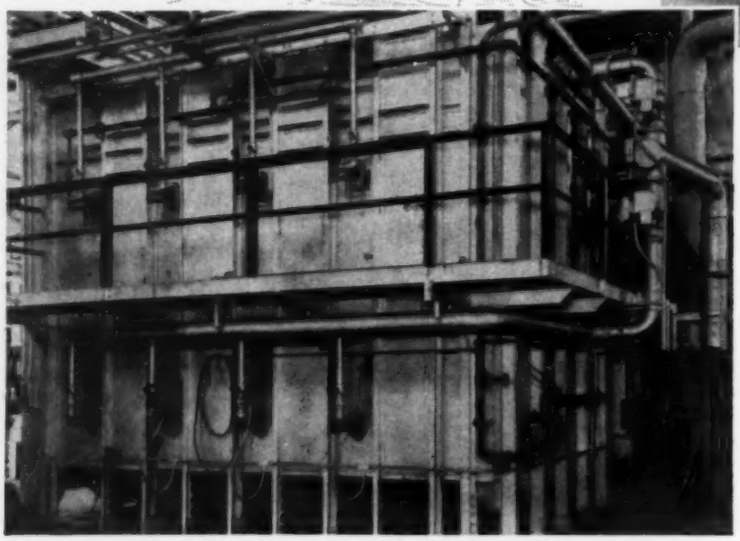
The 16 principal classifications comprising the UNITED ROLL LINE . . . each one a roll type successfully used in modern industry . . . are individually and distinctively *color-branded* to designate *type, composition* and *service application.* Roll selection is thereby made easy and accurate.

UNITED ROLLS are the product of advanced metallurgical research and more than 40 years experience in roll design and manufacture.

LOFTUS
Tailor-Made FURNACES







FOR EVERY JOB in the Steel Mill

Pictured on this page are three of the many and varied types of industrial furnaces designed, engineered and constructed by the Loftus Engineering Corporation.

Loftus is fully equipped to handle any furnace construction problem that you may have—however difficult or exacting.

All Loftus furnaces are tailor-made to meet individual requirements. Their sound design and rugged construction insure higher efficiency at lower operating costs.

Inquiries are invited for all types of Industrial Furnaces, Melting and Heating Furnaces and related equipment for the Steel, Foundry, Aluminum and Brass Industries.

LOFTUS ENGINEERING *corporation*

610 SMITHFIELD ST PITTSBURGH, PA.

Designers and Builders Engineers, Consultants, Contractors

Factory-wired, conveniently packaged Reliance V★S Drive provides unlimited range of adjustable speeds for Diesel locomotive axle grinder . . . from A-c. circuits.

Whatever *your* product, whatever the machines used in making it, Reliance V★S Drive can increase the speed of production — and reduce your costs at the same time. V★S, the *All-electric, Adjustable-speed Drive operating from A-c. Circuits,* has done just this in many thousands of diversified applications.

Using A-c. power, the V★S Drive offers you unlimited flexibility of operation through automatic or manual control, either at the machine or from remote stations. Specifically, this means quick, smooth starts and stops, stepless speed changes, maintenance of proper tension and reversal at any desired point. Available in sizes from 1 to 200 horsepower. For more details of V★S operation, return coupon below today!

RELIANCE V★S DRIVE

RELIANCE ELECTRIC & ENGINEERING CO.
1084 Ivanhoe Road • Cleveland 10, Ohio

Appleton, Wis. • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Denver
Detroit • Gary • Grand Rapids • Greenville, S. C. • Houston • Kansas City
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San Francisco • Seattle • Syracuse • Tampa • Tulsa • Washington, D. C.
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MAIL THIS COUPON TODAY!

RELIANCE A-C D-C MOTORS
"Motor-Drive is More Than Power"

RELIANCE ELECTRIC & ENGINEERING CO.
1084 Ivanhoe Road, Cleveland 10, Ohio

Please send your Bulletin 311 describing the operation and advantages of the Reliance V★S Drive.

NAME_____
COMPANY_____
TITLE_____
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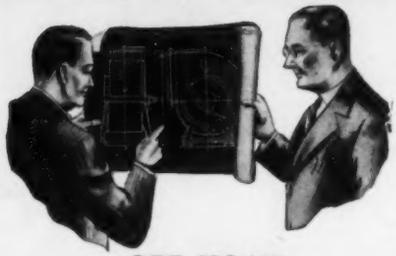
CITY_____ ZONE_____ STATE_____

TURN FAN POWER INTO MORE AIR



SEE YOUR CONSULTING ENGINEER

His advice is always worth its price! The **right** fan, installed in the **right** place with the duct work he recommends will give you just the air service you need for many economical years.

THIS FAN STEPS UP EFFICIENCY *IN MANY AN AIR JOB*

Due to the huge variety of air needs in industry today, fans must be "specialists" to do the job to satisfaction and still save money. "Buffalo" builds such fans.

The "Buffalo" Axial Flow Fan above, for instance, fits into a duct system where space is short — will give excellent ventilation either by itself or as a **supplement** to an existing fan. Note the stationary inlet vanes which give air a true axial-flow, free of power-wasting turbulence, and eliminate loss from rotary air motion . . . resulting in extremely high efficiencies in many installations today.

Why not write us today for Bulletin 3533-B, which shows the many ways in which "Buffalo" Axial Flow Fans can give you better air service.

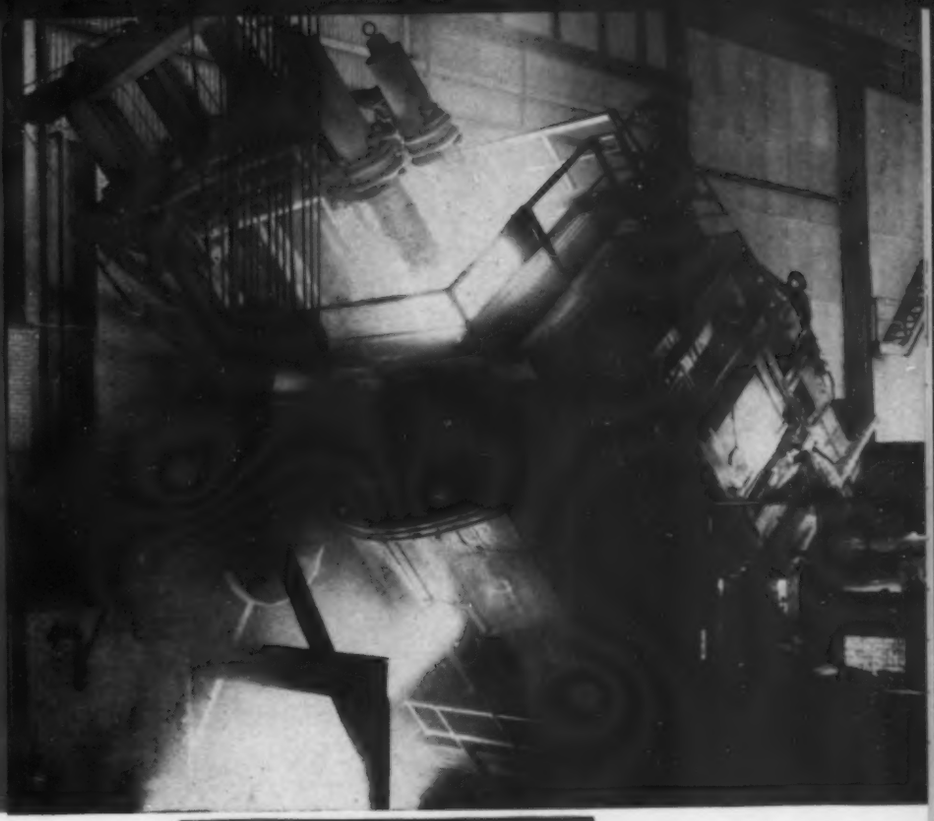
BUFFALO FORGE COMPANY

173 MORTIMER STREET BUFFALO, NEW YORK

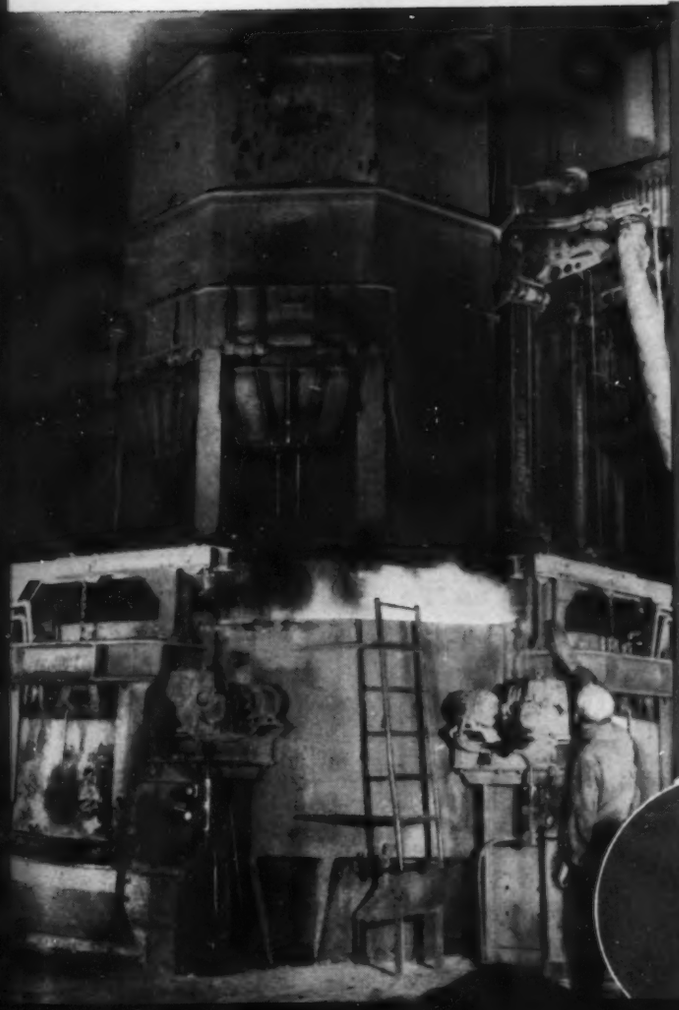
[CANADIAN BLOWER & FORGE CO., LTD., KITCHENER, ONT.

"Buffalo" AXIAL FLOW FANS

EVERY PRODUCTIVITY ADVANTAGE



SWINDELL



Electric Arc MELTING FURNACES

- SIMPLICITY OF CONTROL for operating economy.
- SMOOTH, COORDINATED OPERATION for high production rates.
- STURDY CONSTRUCTION for dependable long life.
- SPECIALLY DESIGNED for individual plant and power conditions.

Let us work with you on your coming requirements!

SWINDELL-DRESSLER Corporation

P. O. BOX 1888 · PITTSBURGH 30, PA.

Where

MIGHT

is

RIGHT

Strength, wear resistance, rigidity and surface perfection . . . those are the demands you must satisfy. Ohio Steel can supply the RIGHT ROLLS for every type of rolling job.

Ohio Rolls

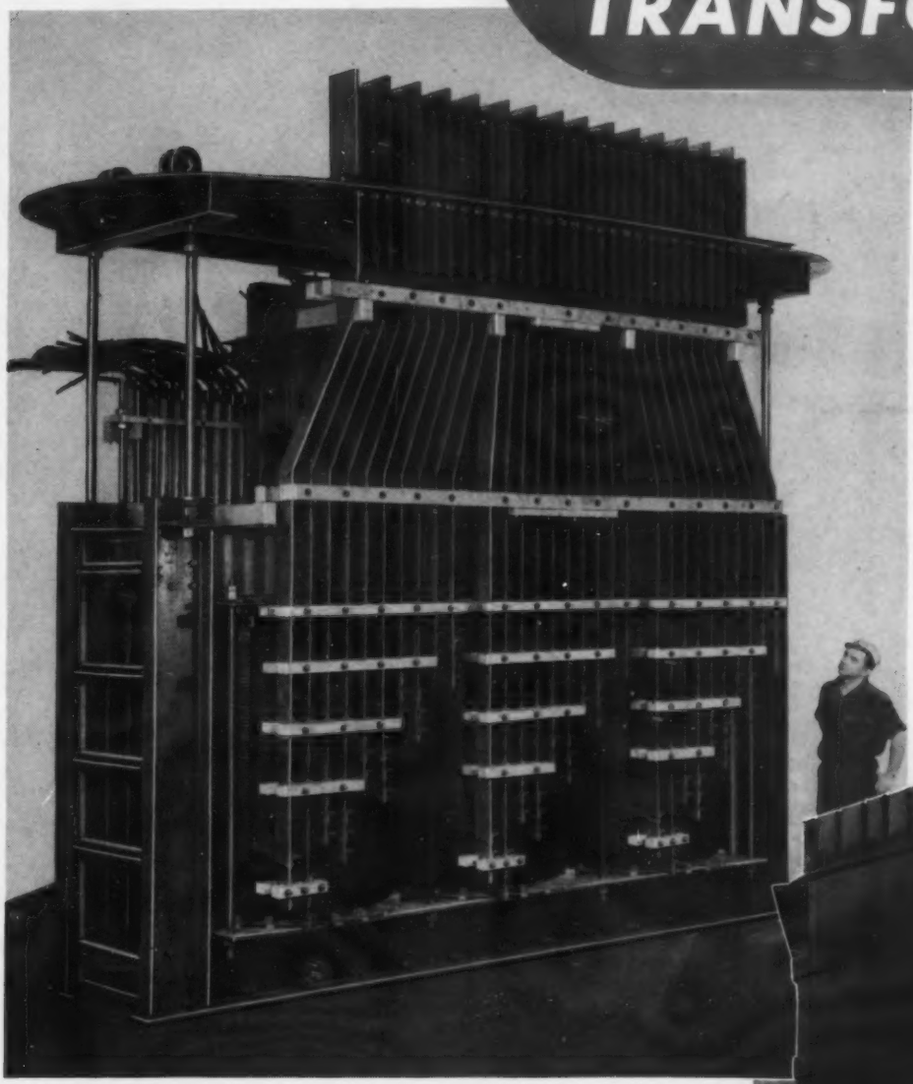
SHAPING METAL FOR ALL INDUSTRY

Select from any of these eleven types of Ohio Steel and Iron Rolls: Carbon Steel Rolls, Ohioloy Rolls, Ohioloy "N" Rolls, HOLL-O-CAST Rolls, Chilled Iron Rolls, Alloy Chilled Iron Rolls, Dense Iron Rolls, Nickel Grain Rolls, Special Iron Rolls, Nioloy Rolls, Flintuff Rolls.

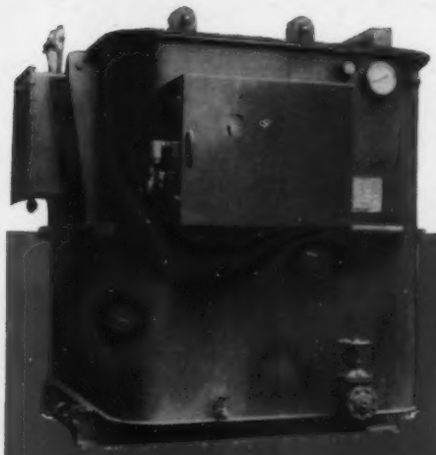
THE OHIO STEEL FOUNDRY COMPANY ★ LIMA, OHIO

Plants at Springfield and Lima, Ohio

Iron and Steel Engineers prefer PENNSYLVANIA FURNACE TRANSFORMERS



For over 30 years the designers of Pennsylvania Transformer Company have paced the industry in the development and construction of Electric Furnace Transformers. Many special conditions, not encountered in ordinary transformer design, such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses, have been met by continual research and sound engineering practice. The large number of Pennsylvania Furnace Transformers serving the steel industry today attest to their reliability and efficiency of performance.

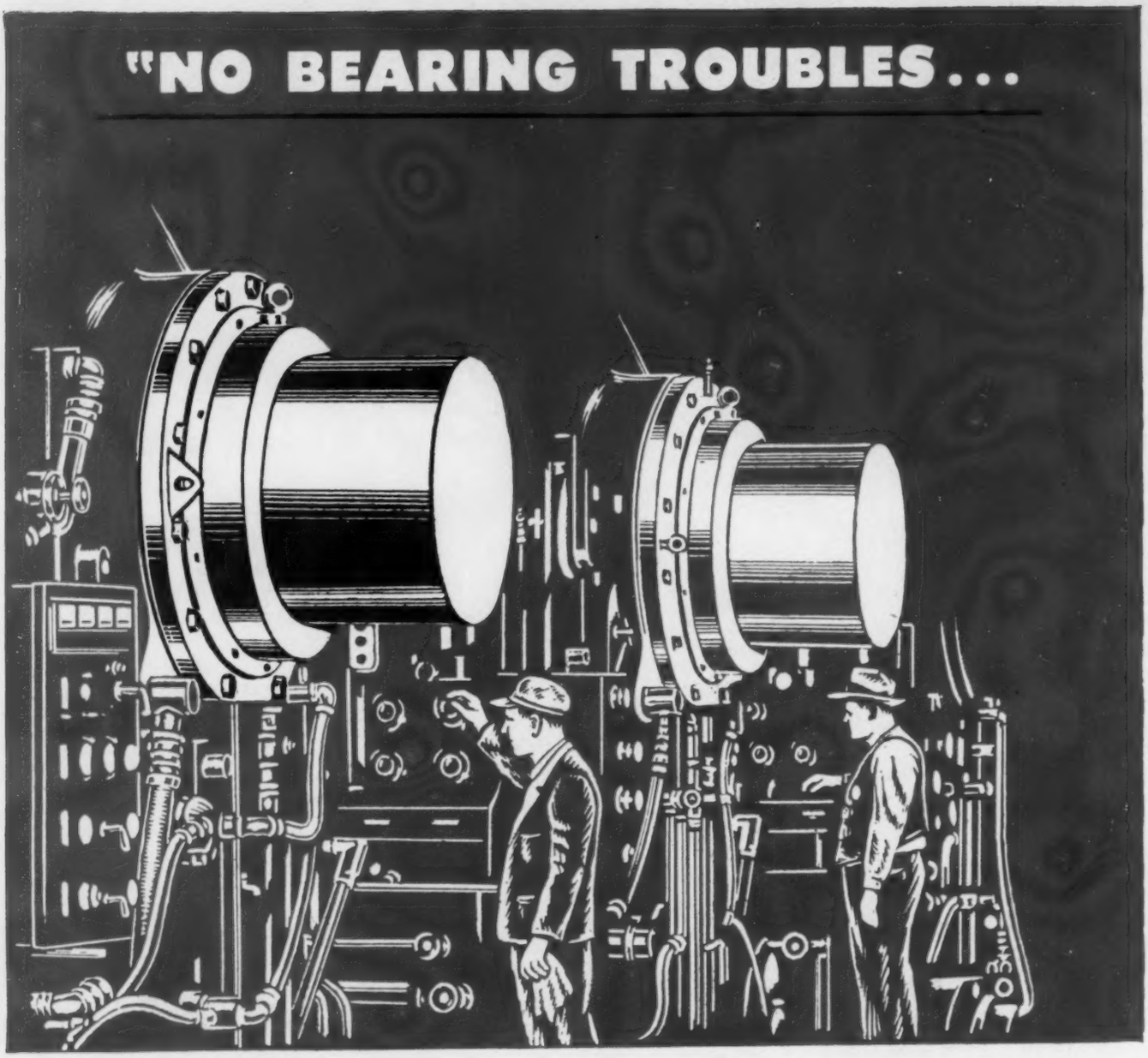


TOP 7500 Kva, 3 Phase, 25 Cycles, 40° C Rise, 12,000-240 volts, 33,300 Amperes.
RIGHT 7500 Kva Transformer mounted on flatcar for shipment.
LEFT 7500 Kva, 3 Phase, 60 cycles, OIWC, 13,200—255 volts

Pennsylvania TRANSFORMERS

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVE. PITTSBURGH 12, PENNA.

"NO BEARING TROUBLES...



with Tycol E. P. Lubricants"

"Not a bearing overheated . . .
Service-life doubled . . .
Races undamaged . . .
Better performance . . .
Maintenance costs cut . . ."

—were the statements made recently by a lubricating engineer. "Yet," he went on, "the anti-friction bearings in our plant operate continuously under severe heat and moisture conditions—tremendous loads."

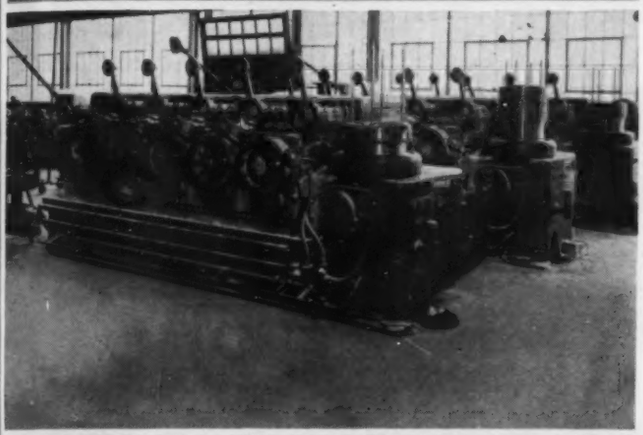
This is one of the many uses of Tycol E. P. Lubricants. For more information call, write, or wire your nearest Tide Water Associated Office.

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

LUBRICATION—"ENGINEERED TO FIT THE JOB"



PEG PRODUCTION HIGH

. . . NAIL COSTS DOWN

with Modern, Efficient

Vaughn

COLD DRAWING MACHINERY

First and foremost in your calculations of products, markets and profits is the constant factor of top machine productivity — when your cold drawing equipment bears the VAUGHN nameplate! This definable performance is achieved with maximum operating economy, by superior design engineering throughout the complete Vaughn line. Let us relate these facts to your manufacturing program !

THE VAUGHN MACHINERY COMPANY

CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT

for the Largest Bars and Tubes — Continuous or Single Hole for the Smallest Wire

Ferrous, Non-Ferrous Materials or their Alloys

✱ 'Surface' Continuous Annealing and Normalizing Furnace for treating a wide range of plate, varying from 3/16 inch to 1½ inches in thickness and up to 110 inches width. This furnace has a total inside length of 123 feet, of which 75 feet is devoted to the heating zone and 48 feet to the cooling zone.

It is equipped with 'Surface' High Pressure Velocity Burners for above and below hearth firing in the heating zone, and underfiring burners in the cooling zone to offset radiation losses when it is operated for blue annealing or slow cooling. In order to provide an extremely wide range of cooling, the cooling zone is equipped with a special flue gas cooler, dehydrator and recirculator.

'Surface'

SURFACE COMBUSTION CORPORATION •

NACES *for* BIG MATERIALS

AT LUKENS PLANTS...

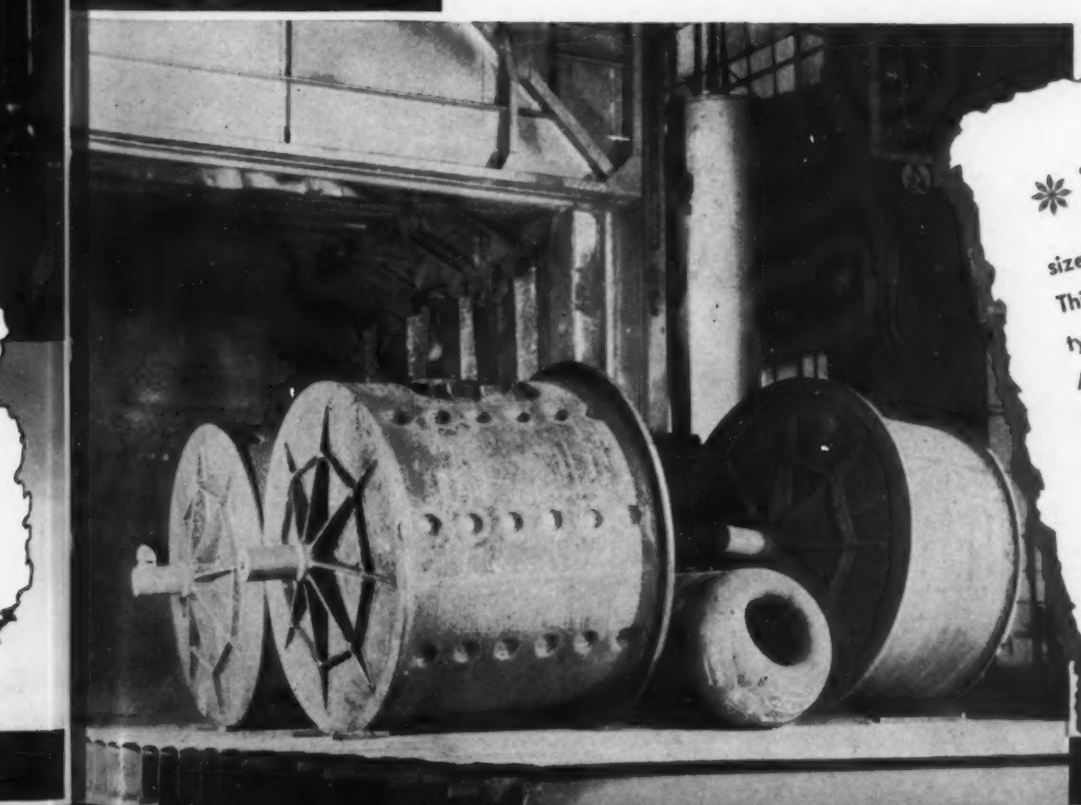
'Surface' PROVIDED FURNACES FOR SIZE, AND EXACTING CONTROL AND FLEXIBILITY OF USE, TOO!

FURNACE EQUIPMENT in steel producing and fabricating may necessarily be of special nature to meet the requirements of the materials to be processed. At Lukens Steel Company, and one of its subsidiaries, Lukenweld, Inc., this problem has been taken care of with the use of 'Surface' Industrial Furnace Equipment, especially engineered for the job.

Two of these units are herewith illustrated . . . a continuous annealer and normalizer—one of the largest of its type known for the processing of plate, and a giant size car-bottom type stress relieving furnace which utilizes convection heating in its operation.

These furnaces are representative of the almost unlimited kinds of furnaces and heating equipment 'Surface' offers to the steel mill. This equipment includes One-Way Fired Soaking Pits—Slab Heating Furnaces —Billet Reheating Furnaces—Continuous Heat Treating Furnaces for Plate —Pit Type Convection Furnaces for Annealing Rod, Wire, or Strip in coils— Continuous Strip Annealers and Normalizers—High Alloy Rod and Bar, Atmosphere Annealing Furnaces of Car-Bottom, Lift-Cover Type—Bright Annealing and Normalizing Furnaces for Tubing—Stress Relief Furnaces— Wire Patenting Furnaces—Annealing Covers, and the foremost equipment in Prepared Gas Atmosphere Generators for practically every heat treating operation.

It will pay you to submit your present heating and heat treating problems to 'Surface' for up-to-the-minute engineering advice and equipment.



✱ 'Surface' Car-Bottom Type Stress Relieving Furnace is used for various sized fabricated structural steel parts. This furnace is of a recirculating hot air type and is equipped with a 'Surface' Air Heater and a recirculating fan, mounted on the furnace top. It has a maximum load capacity of 80,000 pounds. Internal length from door to rear wall 21'-6"; Internal width from wall to wall 18'-6"; Width of car deck 16'-0", and height from top of rails to underside of return air ducts is 11'-0".

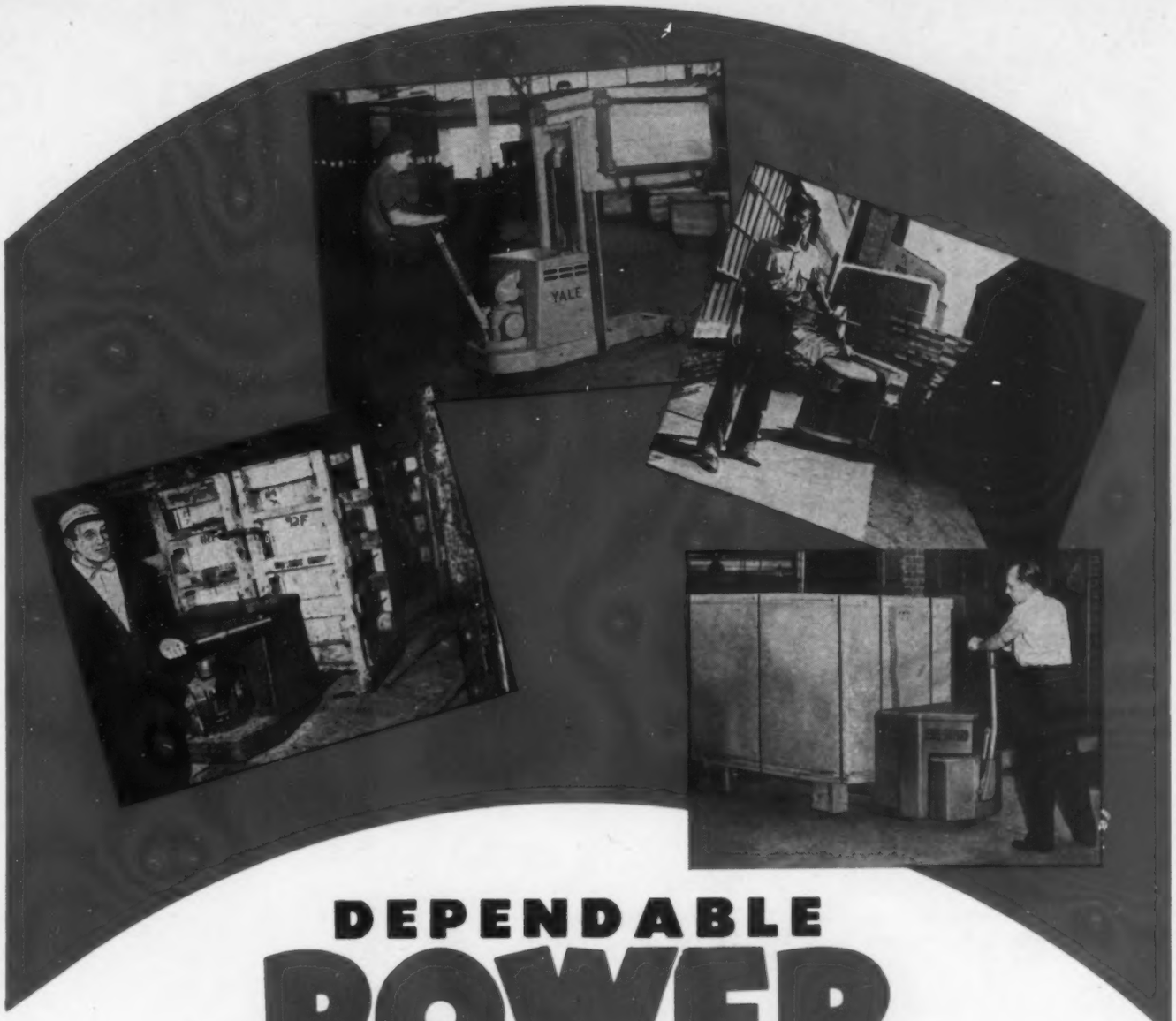
TOLEDO 1, OHIO

Increased production, faster materials handling and greatly reduced handling costs are some of the important economies brought to industry by the Electric Battery Hand Truck. It can be handled by one man with amazing ease . . . guided through narrow aisles, around sharp turns and up and down grades, always under absolute control. And when batteries are Exide-Ironclads, you are assured of dependable, safe, low-cost performance.

Exide-Ironclad Batteries have the *high power ability* required for frequent "stop and go" service . . . the *high maintained voltage* that repeated lifting and hauling demands . . . and the *high capacity* that assures steady, day-long performance with full shift availability. You can always count on Exides for dependability, long-life and ease of maintenance.

Write us for a FREE copy of Exide-Ironclad Topics which contains "Case Studies" of materials handling problems. It tells how to cut handling costs up to 50% . . . covers latest developments in handling materials from receiving to shipping.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto



DEPENDABLE POWER

Leading Steel Companies Depend on HUNT *Quick-As-Wink* Control Valves

This 56" Four-High Continuous Hot Strip Mill, equipped with Quick-As-Wink valves, was built by the Mesta Machine Co. of Pittsburgh.

SAFE, positive control is important in heavy steel mill equipment. That's why Mesta engineers used Hunt Quick-As-Wink valves in the hot strip mill machinery built for a large Canadian steel company. The Hunt descaling valve, for example, regulates the flow of the high pressure descaling water, and because the opening and closing speeds can be adjusted, the valve eliminates water hammer. The solenoid air valves give dependable, trouble-free control of the descaling valves.

C. B. Hunt & Son, Inc., manufactures single and double solenoid valves in a variety of sizes. Air, hand, foot, and diaphragm operated valves are also available. 2-way, 3-way, and 4-way hydraulic valves are made in pressure ranges up to 5,000 p.s.i.

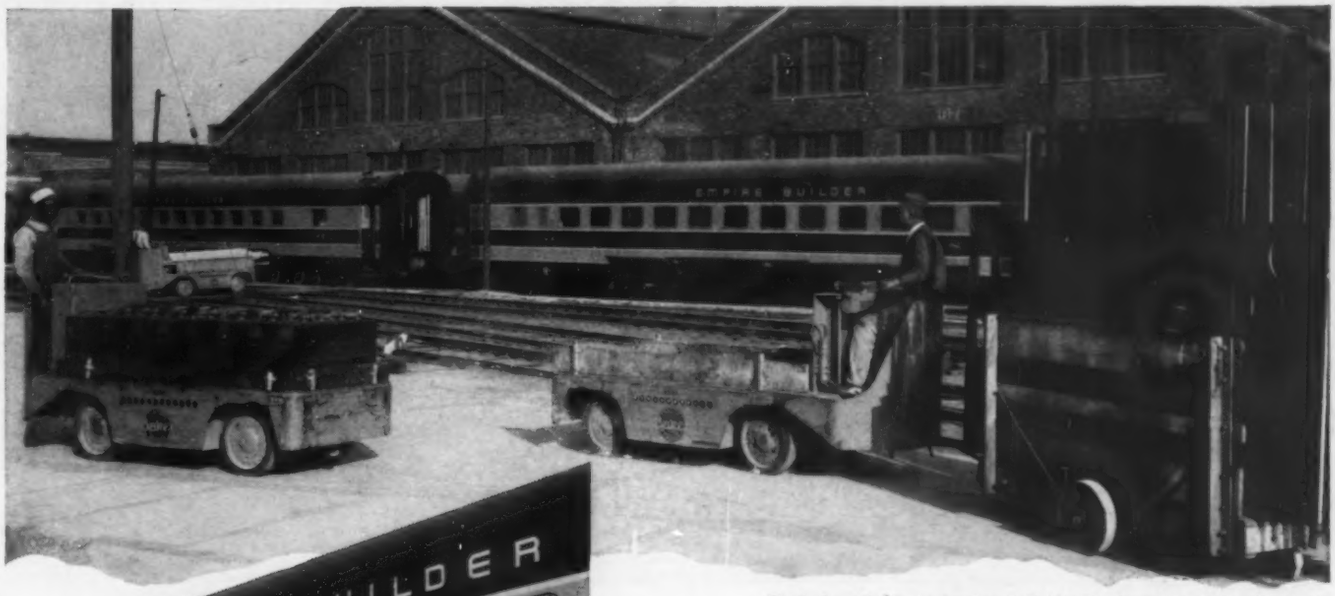
The pilot-operated, 2-way descaling valve is made in sizes 2" to 6" inclusive and for pressures up to 3500 p.s.i.

The solenoid-operated air valve adapts itself to automatic operation by means of time cycle controls or other automatic control devices. Enclosing protective covers – easily and quickly removed – are available for solenoid valves.

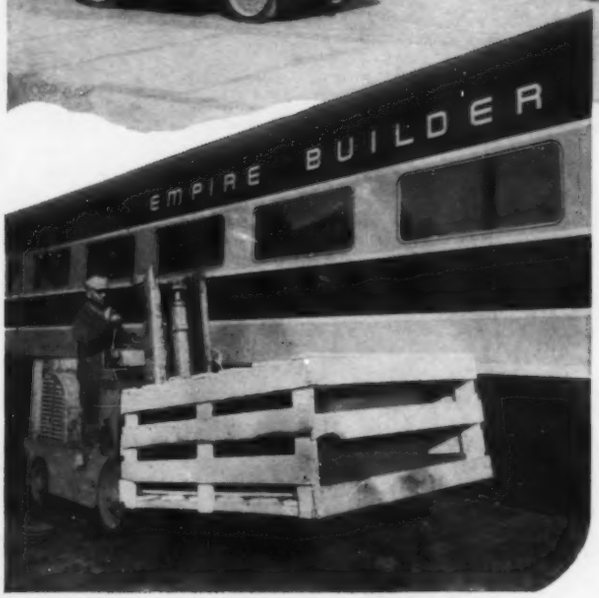
Quick-As-Wink
HUNT CONTROL VALVES

C. B. HUNT & SON, INC., SALEM, OHIO

20 BAKER TRUCKS *mean 80% savings in handling costs at* PULLMAN-STANDARD



Typical yard scene showing 3 Baker Platform Trucks hauling miscellaneous materials to cars. Truck at right doubles as tractor hauling trailer load of car partitions.



Baker Fork Truck carrying crated air conditioning unit, passing in front of nearly completed car for Great Northern's famous "Empire Builder" train.

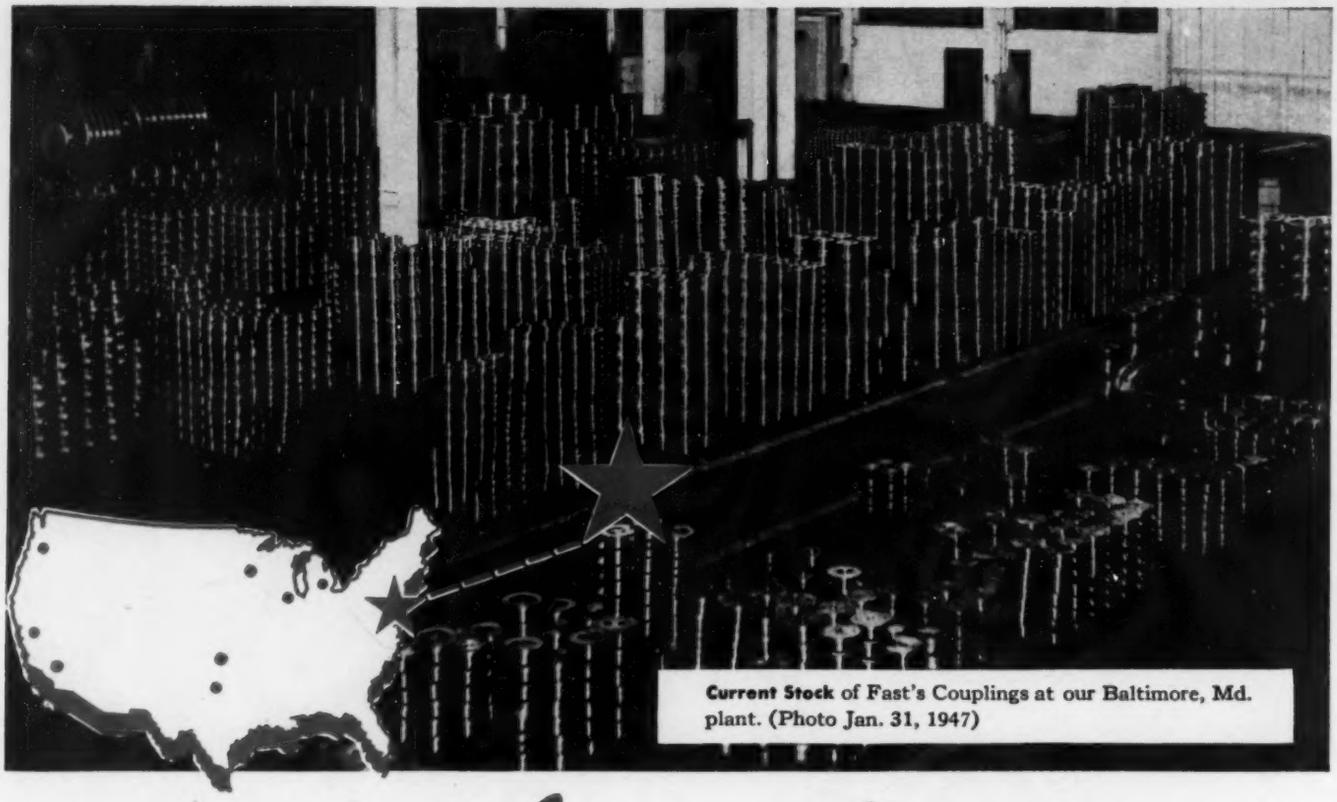
Proper handling is extremely important at the Pullman-Standard Car Manufacturing Co.'s Chicago Plant. The various buildings are scattered over a wide area. A great variety of materials and fabricated parts are received on flat cars, in box cars or highway trucks. These must be unloaded, stored, and moved from storage to fabricating plants or to cars in the process of building. Where possible, materials are handled on skids or pallets, and transported by fork or lift trucks. Miscellaneous items are handled on platform trucks.

20 Baker Trucks, comprising fork trucks, low- and Hy-Lift trucks, platform trucks and crane trucks, form the basis for their modern, mechanized material handling system. Trucks are subjected to strenuous, continuous service indoors and out. According to the superintendent, they are giving highly satisfactory service—effecting an estimated saving of 80% in handling costs.

The Baker Material Handling Engineer can show you how similar savings may be made in your plant. Phone our nearest agent or write us direct.

BAKER INDUSTRIAL TRUCK DIVISION
of the BAKER-RAULANG COMPANY
2166 West 25th Street • Cleveland, Ohio
In Canada: Railway & Power Engineering Corporation, Ltd.

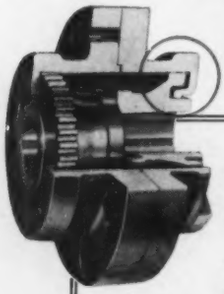
Space in warehouse is conserved by tiering. Baker Fork Truck uses detachable fork extensions for handling crates 80" long.



Current Stock of Fast's Couplings at our Baltimore, Md. plant. (Photo Jan. 31, 1947)

In Emergency, *Immediate* Delivery on FAST'S Couplings

Our usual prompt service on couplings can be stepped up in an emergency. Shutdowns cost money and it is important to remember that Fast's Couplings can be supplied fast—*usually immediately* in an emergency.



We can back up this promise because we maintain a large stock of Fast's Couplings at Baltimore, Maryland, service stocks at Chicago, Illinois . . . Minneapolis, Minnesota . . . Detroit, Michigan . . . and complete stocks at Portland, Oregon . . . San Francisco, California . . . Los Angeles, California . . . Tulsa, Oklahoma . . . and Fort Worth, Texas.

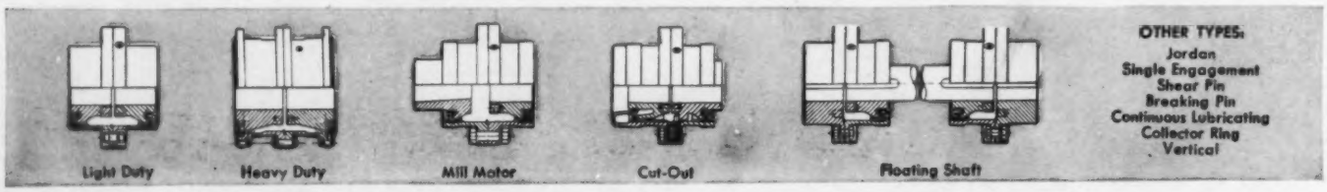
When you specify Fast's Couplings, you can count on them being delivered when you want them. Write . . . wire . . . or phone today to: Koppers Company, Inc., Fast's Coupling Dept., 213 Scott Street, Baltimore 3, Maryland.

Only FAST'S Gives You this Extra Protection

The *exclusive* "rocking bearing," shown in the circle, is one more reason for ordering Fast's Couplings, *now*. It provides a positive metal-to-metal seal to guard the load-carrying oil against moisture, dust and grit. Note that *no* perishable packing rings are used.

KOPPERS

FAST'S *self-aligning* COUPLINGS



FOR DELIVERIES . . .

HOW'S THIS?

Standardized full magnetic D-C. Crane and Mill Controllers in

*6 to 8 WEEKS!

BULLETIN 9136
Bridge and Trolley Crane Control

***EXPLANATION**—Careful planning plus round-the-clock utilization of our manufacturing facilities has greatly increased our productive capacity. However, recent heavy activity in the special engineered class of apparatus has created a degree of unbalance with the result that we now have shop capacity open for the immediate fabrication of Standard Magnetic Crane and Mill Auxiliary Controllers, NEMA Standard Section IC14 and Section IC13, respectively. This includes necessary accessories. Wire or phone our nearest District Office.

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

Best by far for high-speed production

In today's fast-moving production work the modern battery-powered truck has no equal. The development of modern high capacity batteries by Philco, gives trucks for steady, full-shift operation. Philco extra capacity types are widely used—XL, XVL, AMH and the famous long-life Philco "Thirty". Write for catalogs of specification data.

PHILCO

STORAGE BATTERIES

PHILCO CORPORATION • STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

Heppenstall

Rolled and Forged Steel

Rings and Cylinders

Heppenstall Rolled and Forged Steel Rings (weldless, of course) are available in outside diameters of 6 to 50 inches—in widths, or sleeve lengths, of 1 to 24 inches. They can be furnished black, as rolled or forged, or rough finished—in any quantity from 1 to 100,000. They can be of any analysis steel—annealed or heat treated to your particular specifications for physical properties and hardness.

When you consider rolled and forged rings, investigate Heppenstall. There's no obligation in requesting a quotation. Heppenstall Company, Pittsburgh 1, Penna.

H

HEPPENSTALL

The most dependable name in forgings

PITTSBURGH

DETROIT

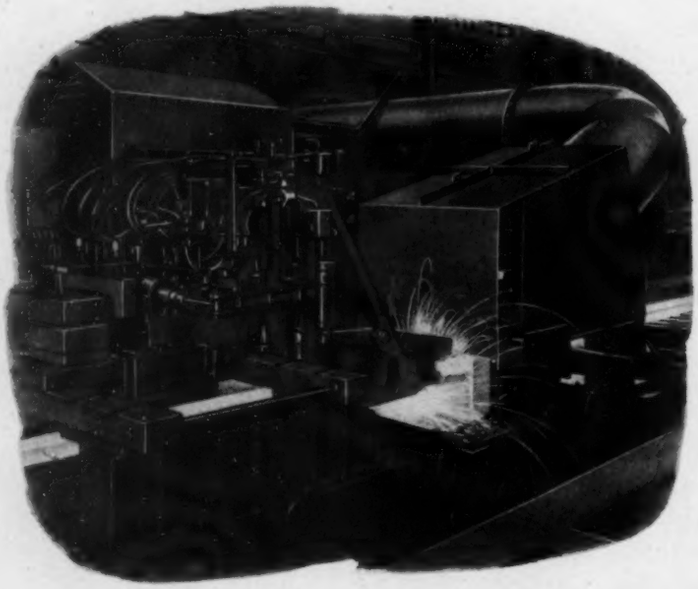
Still looking into the FUTURE!

YESTERDAY
a Revolutionary Process!

Oxyacetylene hand scarfing really set production costs tumbling—in the twenties. It was the oxygen industry's answer to one of the most troublesome problems confronting steel men.

TODAY
What a Difference!

Having pioneered in the development of flame scarfing, the oxygen industry went right on to create machine flame scarfing. It's faster...more efficient... and it is as much as 80% less expensive. First used on low carbon steels with great success, this process was then applied to alloy steels. TODAY—steel men agree that without machine scarfing, low-cost mass-production of modern alloy steels would be impossible.



AND TOMORROW .....?

Airco's research and development staff will continue to work hand-in-hand with steel men to contribute new and better methods of steel production through the use of the oxyacetylene flame...creating the techniques and tools of tomorrow.

Airco's Technical Sales Division is at the call of steel men in applying Airco processes to the solution of their problems. For additional information, get in touch with your nearest Airco office or write: Air Reduction, General Offices, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, General Offices, Houston 1, Texas.

AIRCO **AIR REDUCTION**

Offices in All Principal Cities

POOLE

A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

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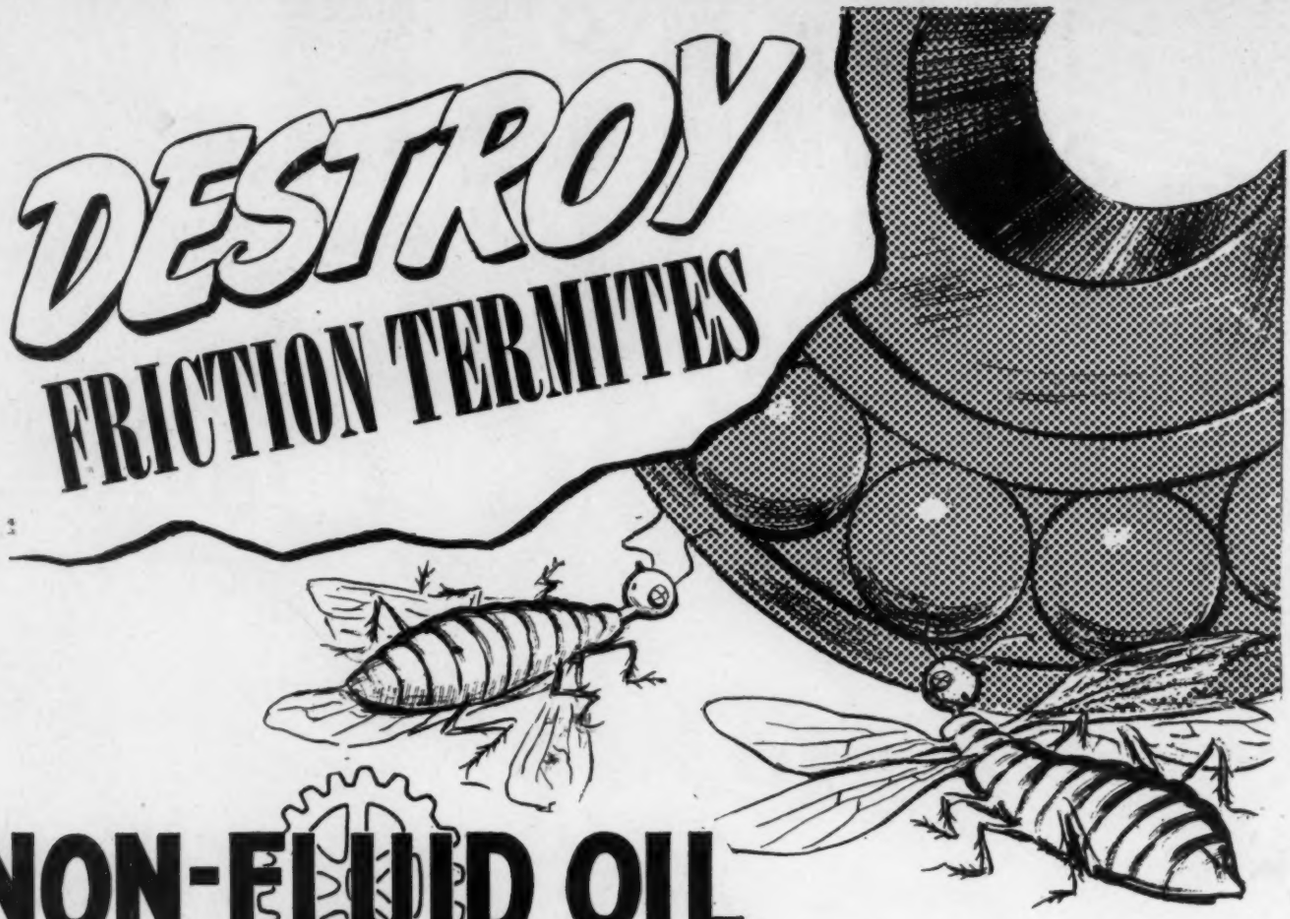

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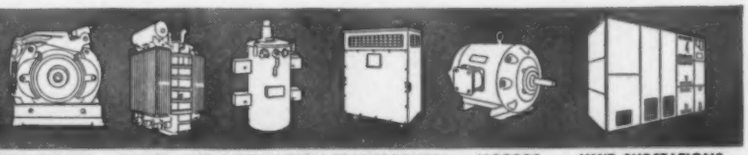

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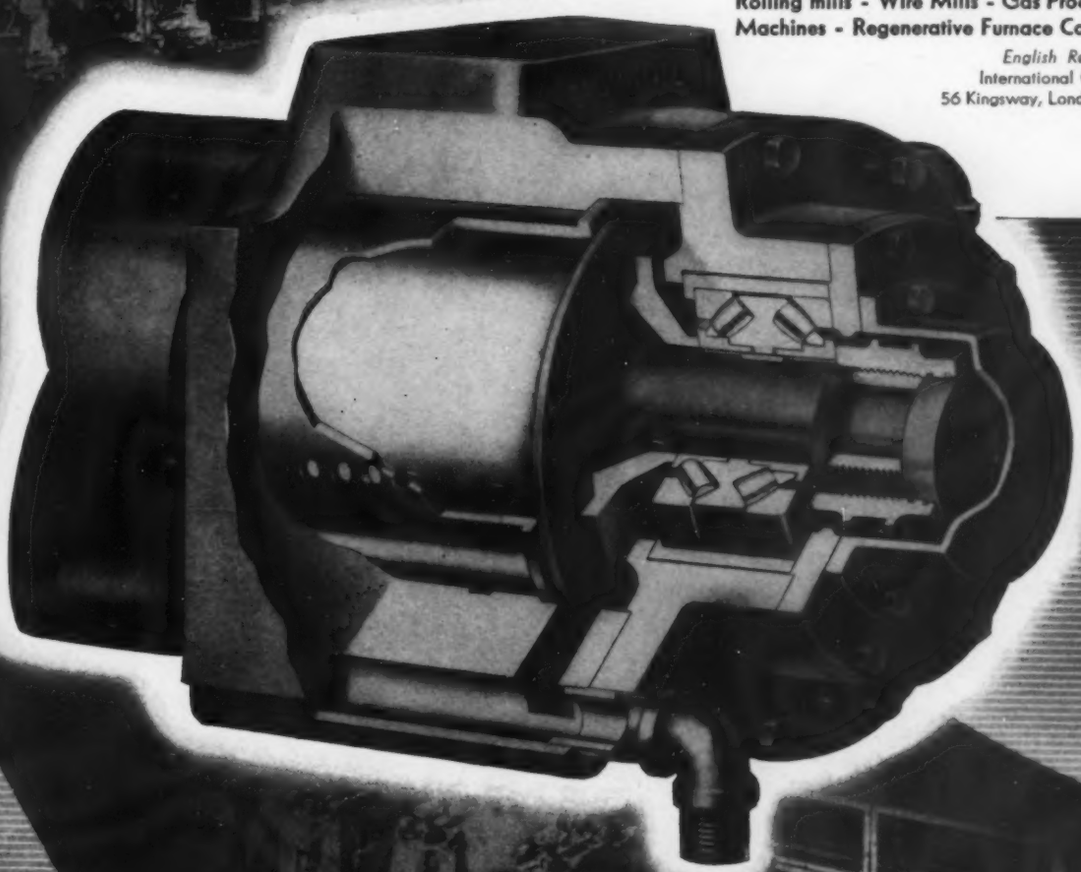
MB-4



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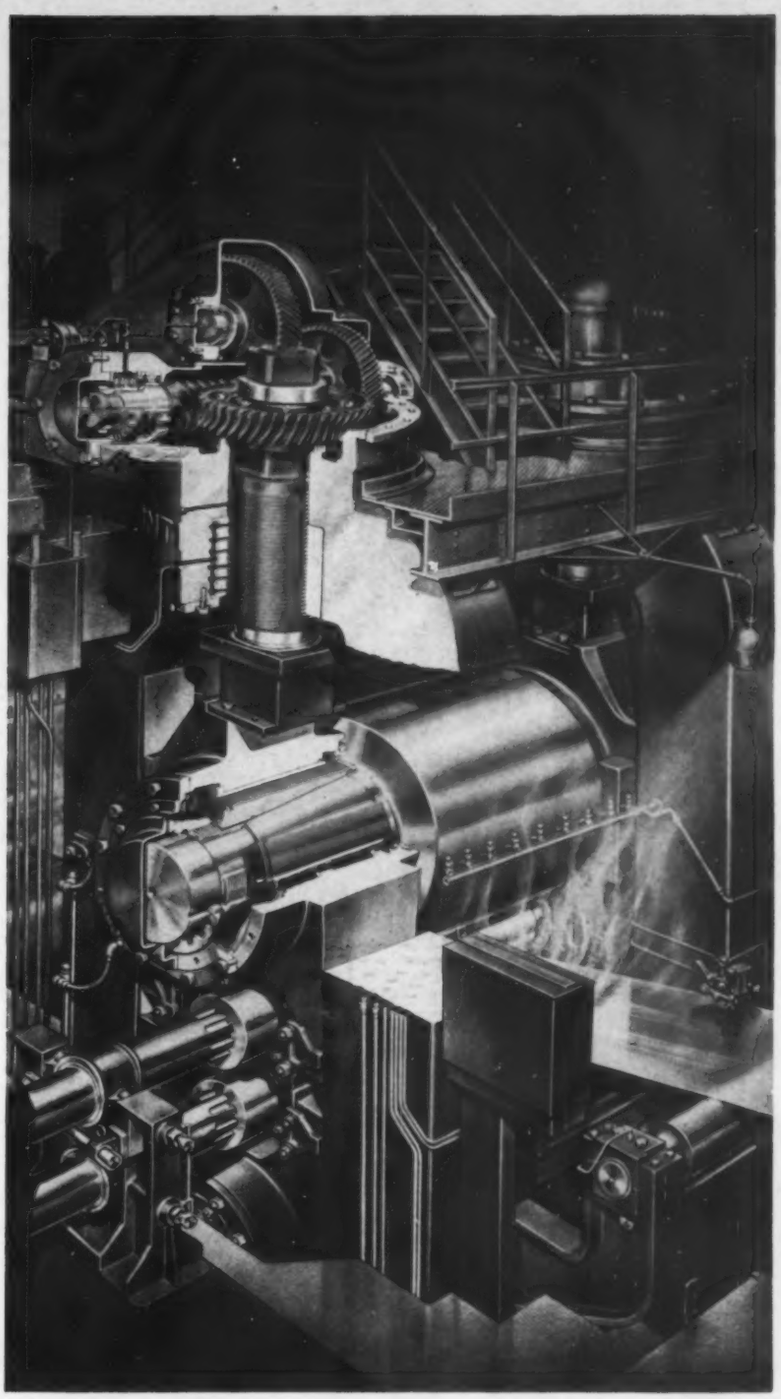

This cutaway drawing prepared with the cooperation of Co: 'inental Foundry and Machine Company.

At more than 1,000 feet per minute, this cold-reduction mill rolls out steel sheet up to 80" wide. Screw-down loads may reach 3,000 tons.

Beating friction and wear under such operating conditions requires highly specialized lubrication.

In the screw-downs, for instance, high pressures and intense wiping action tend to squeeze oil from the screw threads and the worm drive. Gargoyle Compounds provide strong films that bond tenaciously with metal, "stay put" under the rubbing and squeezing action.

In the back-up roll bearings, thin oil films must shoulder all the pressure that the screw-downs deliver. They must stand heat and shock, resist water, fight off deterioration for long periods. Gargoyle Vacuoline Oil is tailored for this purpose.

In the work-roll bearings, Gargoyle Grease Sovarex L provides protection under the same conditions. Look to Socony-Vacuum for the right oils and greases for all your lubrication problems.

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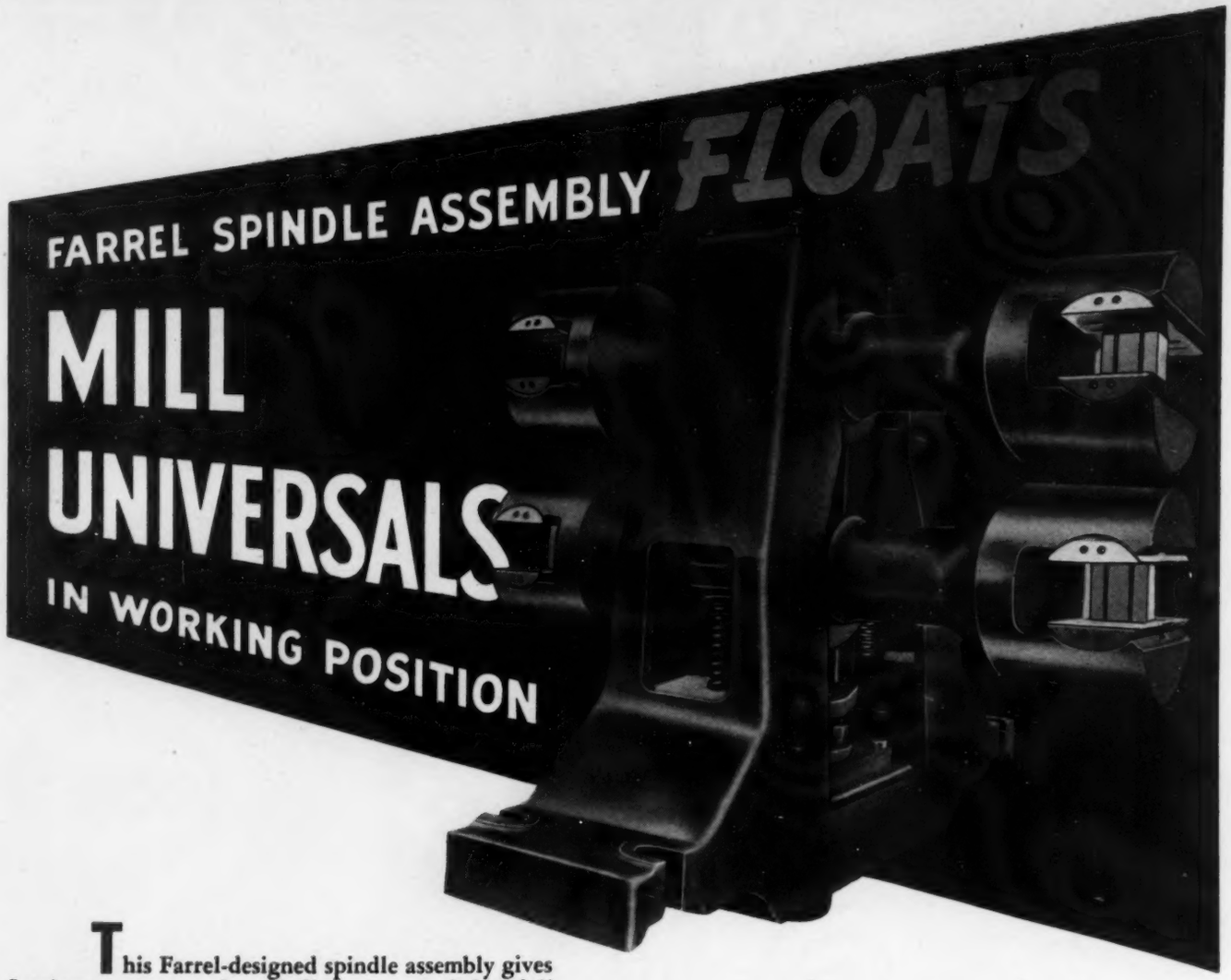

This Farrel-designed spindle assembly gives floating support to the spindles . . . permitting full universal action and eliminating extra burden on either pinion stand or roll bearings.

The lower spindle bearing rests on steel springs, easily accessible for height adjustment. The upper spindle is hydraulically counter-balanced, its bearing being supported by bars extending from a crosshead fastened to the top of the hydraulic cylinder ram. The vertical motion of the upper spindle is actuated by the movement of the mill itself, the hydraulic counterbalance only supporting the spindle so that it is maintained in proper position at all times.

The hydraulic cylinder in the base of the housing receives oil pressure from an accumulator which has a gas-loaded chamber. A pump and motor are employed to build up accumulator pressure and maintain it, in case of leakage, by means of a hydroelectric switch control.

The spindles themselves are of high strength steel, with a heavy cast Meehanite housing for bearing support.

This unit is another example of how Farrel designs and builds equipment to fit the job. Write for complete details of any of the production machinery mentioned on this page.

FB-376

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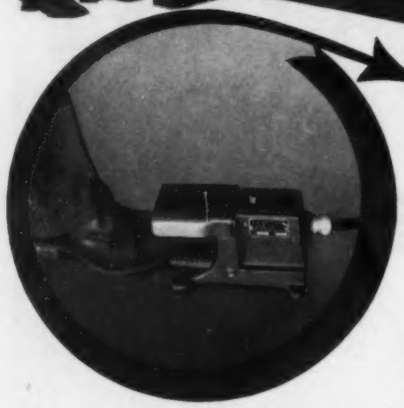

Series No. 410 Shear for cutting steel plate up to 3/8" x 10'-0"

The electric foot switch is one of the many features that makes operation of Steelweld Shears easier and faster. It can be slid around the floor to wherever most convenient. Only a slight movement of the toe is required to operate it. This feature is standard on all Steelweld Shears, and is furnished at no extra cost.

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Like a modern streamlined engine as compared to an old-time locomotive, or a luxury liner versus a tramp freighter, so will you find these new shears as compared to all power shears you have ever used before.

Here at last is something new in shearing history — a great advancement in design and performance — the only truly basic change for many decades.

Not only are these new shears easier to operate but their design assures smooth straight cuts to hair-line accuracy for years of operation. Their construction is extra heavy and all modern features are incorporated to provide for ease of operation, minimum maintenance and long life.

If you shear plate in any thickness to 1¼-inch or length to 18 feet, you should get the facts on these new Steelweld Shears. Send for catalog today.

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STEELWELD PIVOTED BLADE SHEARS

Crops *and* Shorts

AS of the beginning of 1947, steel producing capacity of the United States totaled 91,241,250 net tons, compared with 91,890,560 a year earlier. The new total consists of 81,010,990 net tons of open hearth steel, 5,076,240 net tons of electric furnace steel, 5,154,000 net tons of bessemer steel and 20 net tons of crucible steel. This represents a drop of 225,260 net tons in open hearth capacity and 424,050 net tons in electric furnace capacity. The drop of more than 8 per cent in electric steel capacity is particularly significant, in view of its phenomenal growth during the war.

Blast furnace capacity is now 65,709,200 net tons per year, compared with 67,340,590 net tons a year ago.

▲

PIG iron continues to become shorter and shorter — even to the point of driving some small non-integrated steel producers to consider cupolas to make pig iron out of scrap. Yet at the same time, scrap prices of about $34 per ton are leading some large producers to consider making scrap out of pig iron in open hearth furnaces.

▲

FURTHER evidence of distorted relationship between commodity prices is evidenced by the fact that in 1940 a pound of butter bought about 16 pounds of finished steel; today it buys about 26 pounds. In 1940, a ton of pig iron bought about nine standard white shirts; today it buys little more than seven shirts — if you can find the shirts.

▲

IF you're ever caught without matches, take a cigarette out of the pack; the pack then becomes a cigarette lighter.

▲

FINAL figures for 1946 show that of a total of 53,073,421 net tons of rolled steel products produced, 22,975,834 tons (more than 43 per cent) were in flat-rolled classifications, including plate, strip, sheets, and black and tin plate.

▲

STEEL plant payrolls in 1946 set a peacetime record, according to the American Iron and Steel Institute, of $1,544,142,000. The average number of employees total 575,300, and they worked an average 36.1 hours per week. Of the total, hourly, piecework and tonnage wage earners received $1,208,259,000 for an average of $1.347 per hour.

▲

BASED on the hours and tonnage given in the preceding items, the industry used an overall average of 20.4 man-hours per ton of hot rolled steel products.

▲

IT IS necessary that we learn from the mistakes of others — we just don't live long enough to make them all ourselves.

▲

CLOSE supervision of yield and quality — even to the point of establishing a separate department for such supervision — has paid handsome dividends in some steel plants, where overall yields have been increased as much as 3 or 4 per cent.

▲

ACCORDING to the American Iron and Steel Institute, the steel industry plans to increase its expenditures for plant expansion and improvement in 1947 to $448,000,000, 54 per cent more than 1946 expenditures. A large portion of the funds to be spent this year will go toward expanded facilities for the production of sheet and strip steel.

▲

ONE hears a lot of complaints about lack of speed, on the part of the new Congress in doing away with the many government bureaus which have outlived their usefulness — if such attribute existed. Of little comfort to taxpayers, but rather showing that we have company, is the fact that in England, officials have recently eliminated the job of having a man watch the English Channel to give warning of invasion by Napoleon. The last watcher, who died recently, was paid four pounds a year.

▲

PRELIMINARY reports on the gasification of coal underground are not unfavorable. Since January 21, an isolated section of a mine at Gorgas, Alabama, owned by the Alabama Power Company, has been the scene of this test. A blast of air and steam is played over the face of the coal seam, which was ignited by incendiary bombs. The resultant gas approximates conventional producer gas. It is planned, after quenching the fire, to carefully excavate the seam.

▲

MESSRS. Murray, Green and other labor bigwigs, testifying before the Senate Labor Committee, were unanimous in their condemnation of any labor legislation whatever. They knew of no labor abuses whatsoever. If we really thought they were serious, we might echo the old saw: "There are none so blind as they who will not see."

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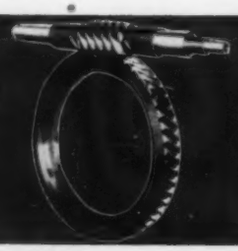
WG-2



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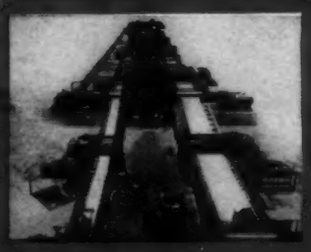
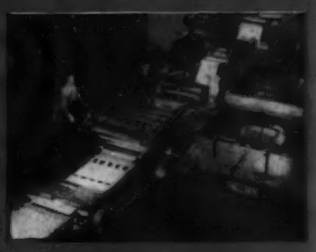


Pickle Line



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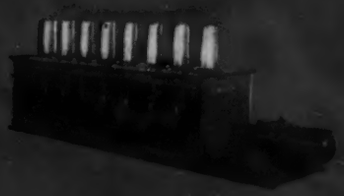

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Strip Reel and Slitting Unit

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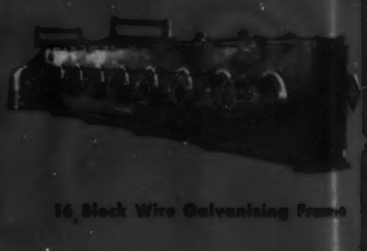

16 Block Wire Galvanizing Frame

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THE MANUFACTURE OF OXYGEN IN LARGE QUANTITIES FOR INDUSTRIAL USES

. . . . recent work in the use of oxygen for open hearth and blast furnace operations shows very promising possibilities in decreasing costs and increasing production . . . . such developments in the steel industry are dependent, however, on obtaining a sufficient supply of oxygen at a low cost . . . .

By MARTIN J. CONWAY, STEEL INDUSTRY CONSULTANT, STACEY-DRESSER ENGINEERING, CLEVELAND, OHIO

▲ COMMERCIAL plants for the production and sale of oxygen were established in America early in 1900, though there was a barium plant operating in New York prior to that period. Since the time when oxygen became available on a commercial scale, there has been an ever increasing demand for cheaper oxygen, which when met, has in turn expanded its uses.

During this time the principal uses for oxygen have been for a product of 99.5 per cent purity, for metal cutting, welding and in more recent years in steel conditioning.

The latest consumption figures for the year 1944 were 19,490,000,000 cubic feet, proportioned to industry as follows:

Unit — Millions cu ft per yr	1941	1942	1943	1944	Per cent 1944
Steel manufacture	4,200	6,000	7,290	7,790	39.96
Shipbuilding	1,300	2,300	3,640	3,900	20.01
Steel fabrication	1,700	2,600	3,640	3,900	20.01
Scrap production	600	900	900	970	4.98
Railroads	500	700	740	780	4.00
Petroleum and chemicals	400	600	550	590	3.03
Airplane, automotive and agriculture	400	500	550	590	3.03
All others	1,400	1,400	900	970	4.98
	10,500	15,000	18,210	19,490	100.00

Presented before AISE Annual Convention, Cleveland, Ohio, October 4, 1946

Acknowledging that these consumptions were for war years, we have no reason to believe that the use of oxygen will decrease, with the possible exception of in the shipbuilding industry.

As a matter of fact, plant production facilities are now under contract which will increase the petroleum industry usage from 3.03 per cent of the annual national consumption to 63.00 per cent and the annual national consumption of oxygen will be increased to approximately 50 billion cubic feet, or an increase of 160 per cent.

This increase is represented by two plants which will each produce 48 million cubic feet of 90 to 95 per cent purity oxygen per working day, one of which is now under construction at Brownsville, Texas. This plant will be operated in connection with the Hydrocol process for the production of rich motor fuel, synthetic diesel oil and crude alcohols from natural gas.

There are two general commercial methods for the production of oxygen: 1. electrolysis of water, and 2. fractionation of air. The first method, electrolysis, is of importance when it is desirable to produce a pure hydrogen stream in addition to the oxygen stream. For the general case where the production of oxygen is the primary objective, the second method, namely liquefaction and fractionation of air, is almost invariably used. There is also a third method of commercial interest, the extraction of oxygen from air by chemical means. Such a process received considerable publicity recently as the result of experiments performed by Dr. Calvin at the University of California whereby

oxygen has been successfully extracted from air by the use of a class of chemical compounds called chelates. In general, at the present time, this method has been limited to small scale operations.

The present paper is based on the production of oxygen by low pressure liquefaction and fractionation of air. This method, while comparatively simple in operation, does require very exacting standards relative to the engineering design of equipment and in the application of control instruments during operation. Fortunately, modern equipment designs and control practices have contributed to both the safety and efficiency of the process with the result that the supervision and operation of an air liquefaction unit may be classified in the same category as the by-product section of the average coke plant.

AIR COMPOSITION

The composition of the air blanket which covers the earth, consists of three principal classes of constituents: first, the common gases, oxygen and nitrogen, together with slight traces of the inert gases of the helium family. These are practically always present in constant proportions in the outside air. The second group of components, which are variable in quantity, includes carbon dioxide, water vapor and dust. The third group, which is present only accidentally, includes various gases such as sulphur dioxide in the neighborhood of smokestacks, oil vapors, traces of carbon monoxide from various sources such as automobile exhaust, switch engines, etc.

The amount of water vapor present in air differs from day to day and in accordance with the various climatic conditions. Carbon dioxide will vary with the locality but stays fairly constant in that locality. The complete dry air analysis is as follows:

	Per cent by volume *
Nitrogen	78.03
Oxygen	20.99
Argon	0.94
Carbon dioxide	0.03
Hydrogen	0.01

* With traces of other rare gases including helium, neon, krypton, xenon and nitron.

For practical purposes, air may be considered as a binary mixture of nitrogen and oxygen which together make up 99 per cent of the whole. The remaining 1 per cent is chiefly argon. In the fractionation process, it is necessary to pay special attention to argon only when relatively high purities are specified for the oxygen and nitrogen streams. Argon has a vapor pressure intermediate to oxygen and nitrogen, and to remove argon from these product streams, additional fractionation equipment is required.

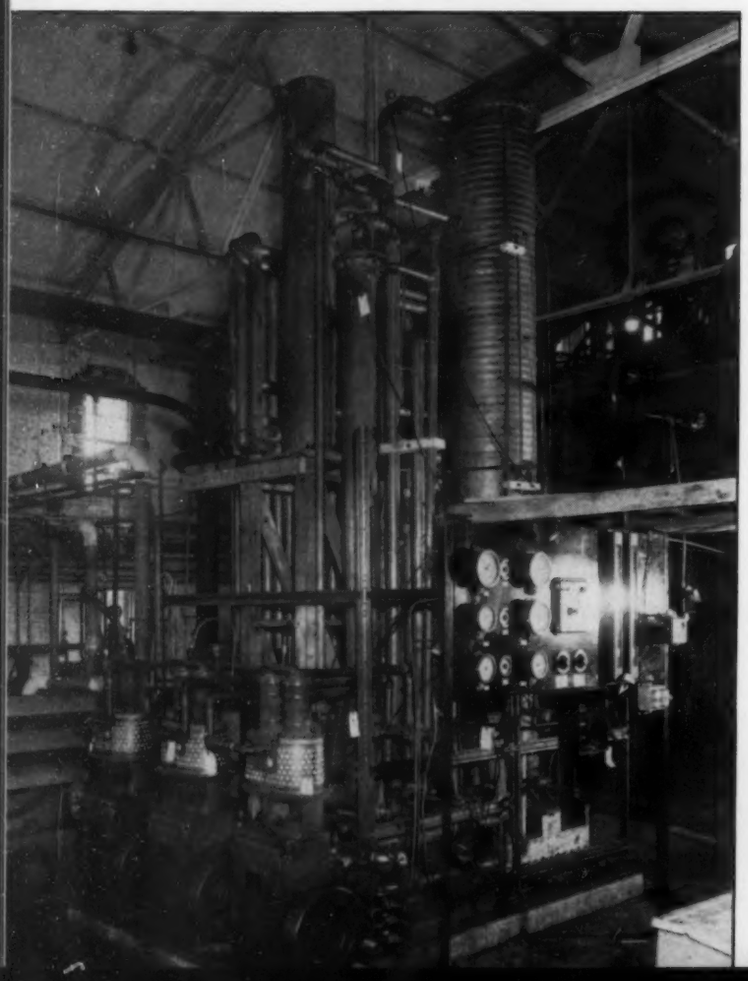
Special provision must be made in the liquefaction process for the removal of carbon dioxide, water vapor and dust. Dust may be removed by the use of suitable dust filters. Carbon dioxide and water vapor may be removed by chemical means or by the use of specially designed reversing heat exchanger equipment.

Through knowledge obtained from the study of small portable oxygen plants constructed during the war and through experimentation with a pilot plant producing 4000 standard cubic feet per hour of oxygen having a purity of 99.5 per cent, it has been successfully demonstrated that oxygen can be produced cheaply by low pressure liquefaction without the necessity for chemical treatment to remove carbon dioxide and water vapor.

The pilot plant referred to was in operation for a period of two years at Olean, New York. It has since been removed to the new laboratories of Hydrocarbon Research, Inc. at Trenton, New Jersey. This pilot plant was constructed to operate as part of a research unit to produce 10 barrels per day of synthetic gasoline from natural gas. The unit operations involved consist essentially of compression, heat exchange, refrigeration and fractionation. Figure 1 is a photograph of the Olean pilot plant.

The flow through the unit is substantially as shown on the flow-sheet in Figure 2.

Figure 1 — This experimental oxygen plant was constructed as part of a unit to produce 10 barrels of synthetic gasoline per day from natural gas.



AIR COMPRESSION

The air passes through a filter to remove mechanical impurities and is compressed to 85 psi gauge in two stages. The compressor is designed to handle 10 per cent excess air to allow for moisture in the air feed and losses in the exchangers on reversal. The air is compressed to 30 psi gauge in the first stage and cooled to 100 F in the intercooler, and the condensed water is

drained off. The air is then compressed to 85 psi in the second stage and discharged into a vertical receiving drum, then into the aftercooler where the temperature is reduced from approximately 300 F to 100 F; it then passes to a knockout drum where the major portions of the oil and condensed water are removed. Some of the equipment items, such as filters and knockout drums, are not shown on the flowsheet.

The residual oil and moisture are filtered out in separators or filters designed for this purpose and the oil vapors are absorbed in passing through a filter containing activated carbon pellets.

The air heater, shown directly above the aftercooler on the flow-sheet, is provided for rapid drying out of the system before and after shutdowns when necessary. During normal operation, this heater is by-passed.

does so without the necessity of chemicals. The oxygen flows continuously through the innermost annulus without interruption and is, therefore, not contaminated either by air remaining in the reversing annuli, or by water ice or carbon dioxide snow. After the air leaves the exchanger, it is discharged into a surge drum at approximately minus 250 F where the main portion, or about 70 per cent, of the air passes directly from the surge drum to be further cooled by exchange against the waste nitrogen before entering the high pressure column. The remaining 30 per cent is used to provide refrigeration.

REFRIGERATION

The enthalpy loss in the products from the unit, that is the difference in heat content between the incoming

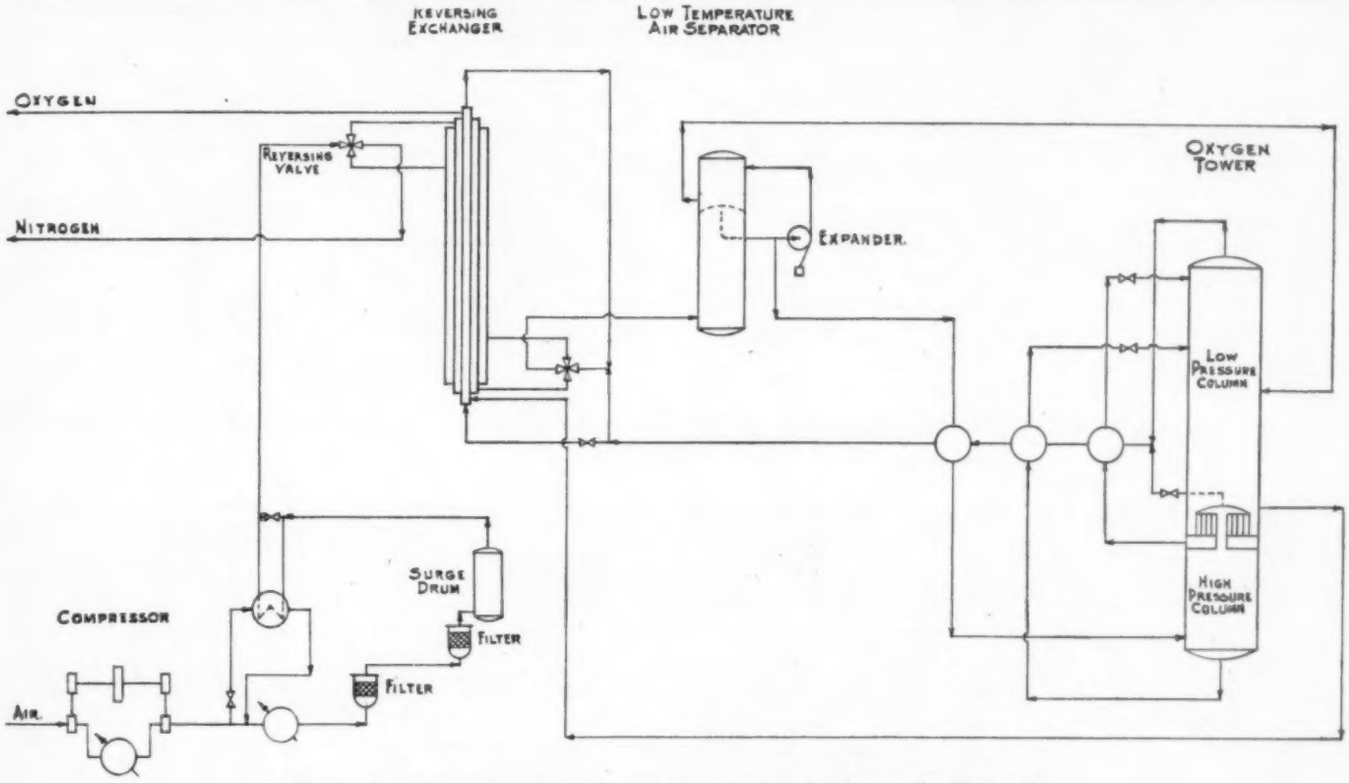


Figure 2 — Flow diagram for experimental unit shown in Figure 1.

HEAT EXCHANGE

The compressed air then flows to a multi-annulus reversing exchanger where it is cooled directly against waste nitrogen and oxygen. As the air is cooled, moisture and carbon dioxide precipitate out of the air and tend to foul the air passage. Before this can happen, however, the flows through the exchangers are reversed. The air is diverted to the annulus which had carried waste nitrogen in the previous half cycle. On the other hand, the waste nitrogen now flows through the annulus which contains the ice and carbon dioxide snow. By this reversal, the ice and carbon dioxide snow are re-evaporated into the nitrogen stream and discharged to the atmosphere. This reversing of flows which cleans the exchanger occurs every three minutes. Thus, the exchanger not only cools but also purifies the air, and air and the outgoing nitrogen and oxygen streams, and also any heat leaks into the system must be made up by refrigeration. This refrigeration is obtained by expanding approximately 30 per cent of the high pressure air through an engine.

This expansion engine does work by compressing an auxiliary air stream, and the heat content of the expanded air is decreased by an amount equivalent to the work of compression. Thus, the temperature of the air decreases from minus 250 F to approximately minus 300 F and thereby supplies the necessary refrigeration to the system. The inlet temperature of the air to the expander is controlled at approximately minus 250 F because at higher temperatures there is sufficient carbon dioxide remaining in the air to deposit out in the expander and cause it to freeze up. At inlet temperatures below minus 250 F, the exhaust gas will start to condense with a resulting decrease in the efficiency of

the expander. The work output of the expander is controlled by throttling the air at the outlet of the compressor before releasing it to the atmosphere.

FRACTIONATION

The cooled high pressure air enters the lower section of the tower below the bottom tray. This section, which is called the high pressure section, contains 20 trays and separates the air into an overhead liquid nitrogen product of low oxygen content and a bottom liquid product containing approximately 35 per cent oxygen.

The nitrogen liquid is subcooled by exchange against the waste nitrogen and supplies reflux to the upper section of the fractionating column where it is introduced on the top tray. This section of the column, which contains 40 trays, operates at approximately 10 psi gauge.

The enriched oxygen product from the bottom of the high pressure column is similarly cooled by exchange against the waste nitrogen and then introduced into the low pressure column as intermediate reflux. The expanded air is also introduced into the low pressure column at an intermediate point.

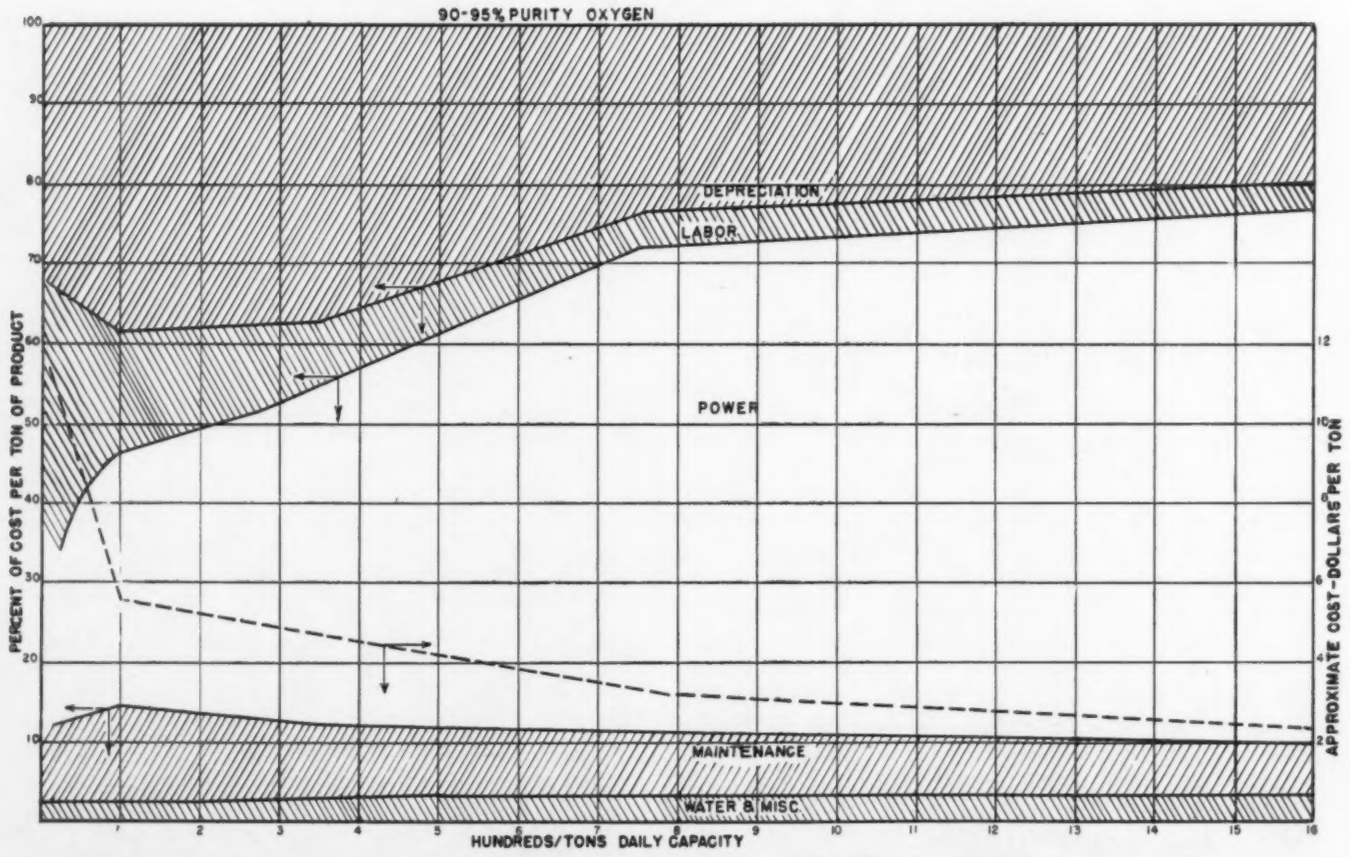
The low pressure tower fractionates the feeds into a waste nitrogen stream which is removed as an overhead vapor and an oxygen product which is withdrawn from below the bottom tray, also as a vapor. The reboiler duty is supplied by the condensation of the overhead vapors in the high pressure section, part of which are withdrawn for reflux to the low pressure section and the balance pass down through the high pressure section as reflux.

In addition to the oxygen and nitrogen, the air feed does contain traces of other gases, such as hydrogen, which are virtually non-condensible, and therefore must be vented from the high pressure condenser to prevent vapor-binding. The accumulation of these non-condensible gases would result in a loss of heat transfer and hence a loss of oxygen production and purity. In order to recover the refrigeration in this purge stream, the stream is vented to the waste nitrogen stream leaving the overhead of the low pressure column.

The air feed may also contain traces of acetylene and other hydrocarbons which will accumulate in the reboiler of the low pressure column. These must be eliminated by periodically withdrawing a small quantity of liquid oxygen from the unit. In larger units, continuous blowdown is provided for.

As previously described, the waste nitrogen passes through the three stationary-flow exchangers before entering the reversing exchangers. The temperature of the nitrogen entering the reversing exchanger is controlled by by-passing a small percentage of the nitrogen stream through the center tubes of the bank of reversing exchangers, and recycling this stream back to the cold end of the reversing exchanger where it is mixed with the main nitrogen stream flowing through the exchanger.

Figure 3 — Estimates for production costs of 90-95 per cent purity oxygen are shown by dotted line for various sizes of oxygen plants. Make-up of costs is shown by other curves.



This recycle stream, which is called an unbalance stream, allows the temperature of the nitrogen stream entering the cold end of the reversing exchanger to be controlled at approximately minus 258 F, thus insuring complete removal of carbon dioxide. Without this temperature control, only part of the carbon dioxide would be re-evaporated thereby eventually causing a shutdown due to excessive pressure drop. The waste nitrogen, after leaving the warm end of the reversing exchanger, is vented to the atmosphere.

The oxygen product passes from the low pressure section of the fractionating tower directly to the inner annulus of the reversing exchanger tubes where its refrigeration is recovered, but its course is not affected by the reversal of the high pressure air and waste nitrogen. The oxygen then enters the service lines and may be subsequently compressed to suit service conditions.

This type of oxygen plant described is made up of a relatively small number of moving parts so that its maintenance and operation require little attention and supervision. The following is a list of the equipment broken down under two headings which indicate the equipment that is stationary and moving.

Moving Equipment

Main air compressor.
Four-way, air operated valves.
3 minutes, single cam, controller.
Expander — compressors.
Oxygen compressor, when required.

Stationary Equipment

Aftercooler.
Filters.
Air heater.
Air surge drum.
Exchangers.
Fractionating towers.
Pressure relieving seal drum.
Panel and instruments.
Nitrogen muffler.
Steel cold box, all piping valves, fittings and insulation.

COST OF PLANT

The separation of high purity oxygen from air by fractionation necessitates the use of apparatus designed to operate at temperature levels as low as minus 300 F. For this low temperature service, the fractionating and heat exchange equipment, together with piping, valves and fittings, must be fabricated from metals having a guaranteed Charpy impact value in excess of 15 foot pounds in the fabricated condition when tested at operating temperatures. All metals suitable for this service (copper, monel, aluminum, 8.5 per cent nickel and stainless steel, etc.), are costly both in the plate and fabricated forms and will cost in the neighborhood of five to one when compared with ASME code vessels for normal medium pressure service.

This equipment cost factor plays an important part in the manufacturing cost of oxygen in small plants, but as the plants become larger, then the cost of power is the most important item, and especially so where power exceeds 5 mils per kilowatt-hour.

The unsettled price relationships between commodities and wages make it extremely hazardous for any oxygen plant manufacturer to make absolute cost predictions. However, certain items are more or less static and their proportional effect on the cost of manufactured oxygen is shown on Figure 3.

This graph is not intended to interpret correctly the exact cost of oxygen at all points of the scale but it does show trends proportional to the daily output in the several items entering into the production cost as the plants increase in size. The bases on which the graph is drawn are: 15 year depreciation; labor, including all indirect labor costs, at $2.00 per hour; power at 5 mils per kilowatt-hour; and maintenance at 2 per cent of the capital investment. The relation between cost per ton and cost per 1000 standard cubic feet is shown on Figure 4.

FUTURE USES

As already stated, the advent of cheap oxygen opens up new uses and applications which cannot be entirely appraised at the moment.

The steel industry is interested in both blast furnace and open hearth applications, and a great deal of preliminary research has been done along these lines. E. A. W. Jefferies presented a paper at the fifteenth annual convention of this association in 1921 titled "The Influence of Cheap Oxygen on Economy of Fuel and of Time" in which he visualized with uncanny foresight many of the uses for oxygen which are being actively tested in several locations at the present time. J. B. Fortune, M. Sc., M. I. Mech. E. in his article "Dehydration and Oxygen Enrichment of Blast Furnace Air" published in the July 1944 issue of Metallurgia, outlines some of the progress made in oxygen enrichment of blast furnace air, up to that date, indicating that the first large scale tests were made in Belgium in 1913 with a reported 12 per cent increase in pig iron production and 3 per cent coke reduction, resulting from enrichment up to 23 per cent oxygen.

Twenty years later at Oberhausen, Germany, an experimental furnace worked for 260 days in 1932 and two months in 1933. In one test, enrichment to 26 per cent oxygen resulted in a coke saving of 14 per cent and an increased output of 12 per cent.

Another series of tests on ferro-manganese production proved that with blast enriched to 30 per cent oxygen content, a saving of 1008 lb of coke per ton of ferro manganese produced.

The Russians, in 1936, after four years of tests on an experimental blast furnace, recorded the following possibilities for further investigation:

1. Hot blast enriched by oxygen, the least radical method of all, and the one proposed for the Makejevka furnace, using existing furnace plant and stoves. Oxygen concentration is usually below 30-32 per cent.
2. Cold blast with more than 30-32 per cent oxygen — additional heat in the shaft to be provided by blowing heated gases into the shaft. Intensive hearth cooling required; injecting water vapor into the hearth suggested.
3. Enrichment to 55-60 per cent oxygen to give blast furnace gas suitable for ammonia production. Hearth temperature must be reduced.

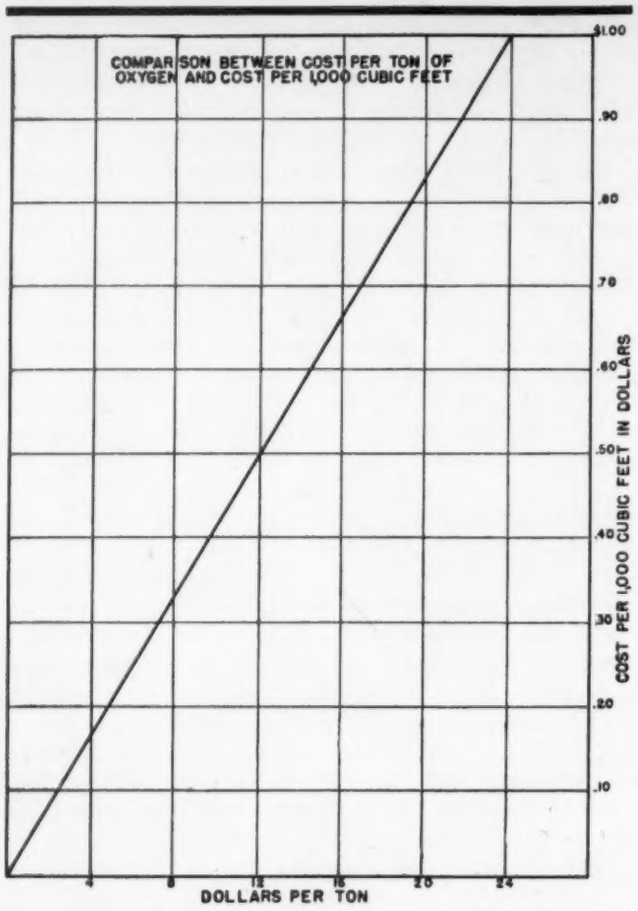


Figure 4 — Conversion chart to change cost per ton to cost per 1000 cubic feet.

4. Radical decrease in coke consumption, cold blast, and hot reducing gas introduced into shaft.
5. Direct steel process, charge coke peripherally, so reducing carburization.

Great stress was laid on the production of high grade industrial gas and increases of production up to 55 per cent were predicted.

That the Russians have not wasted the intervening time, is recorded by Dr. Irving Langmuir in his article "My Trip to Russia" published in the March 25, 1946 issue of Chemical and Engineering News, in which he states that a large oxygen plant is now under construction for use in both blast furnace and bessemer converter operations, and plans are under way for reconversion of the whole Russian steel industry to use oxygen on a large scale.

The possibilities of synthesis gas production on a large scale cannot be overlooked now that cheap oxygen is available, together with its application to several operations in the heavy chemical industries.

Dr. P. C. Keith, in a paper presented before the American Gas Association last May, titled "Gasoline from Natural Gas" provides an excellent forecast on the future uses of oxygen in the closing paragraph of his address, as follows: "In summary the successful development of the processes just reviewed will assure this country of an adequate supply of cheap gasoline, city gas and petroleum products for centuries to come; make available cheap oxygen for use in the chemical and metallurgical industries as well as in the gasoline and gas industries; and provide cheap raw materials particularly carbon monoxide, hydrogen and oxygenated hydrocarbons, to serve as a basis of a great new synthetic chemicals industry."

DISCUSSION

PRESENTED BY

J. H. STRASSBURGER, Manager Department of Service and Maintenance, Weirton Steel Company, Weirton, West Virginia

F. JANECEK, Blast Furnace Engineer, Republic Steel Corporation, Cleveland, Ohio

M. J. CONWAY, Steel Industry Consultant, Stacey-Dresser Engineering, Cleveland, Ohio

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Baltimore, Maryland

C. E. AGNEW, Consultant, Blast Furnace and Sintering Plant Operations, Shaker Heights, Ohio

N. A. SPECTOR, Chemical Engineering Laboratory, The M. W. Kellogg Company, New York, New York

F. E. KLING, Steel Works Engineer, Youngstown, Ohio

H. S. HALL, Fuel Engineer, Lukens Steel Company, Coatesville, Pennsylvania

K. C. McCUTCHEON, Assistant to Vice President, the American Rolling Mill Company, Ashland, Kentucky

J. H. Strassburger: The production of oxygen at $3 and less per ton opens up the field of oxygen for the operation of blast furnaces, open hearths and bessemers. At the present time, we know that many experiments are being conducted in the use of oxygen on open hearth furnaces, and the results indicate that oxygen at about $3 per ton will bring about a saving in fuel which more than pays for the cost of the oxygen. At Weirton we started the operation of a high-purity oxygen plant on January first of this year. This plant has a total capacity of 8000 cubic feet per hour, or about eight tons per day. The plant has been successfully operated and it has offered no serious operating, maintenance or repair problems.

A high-purity plant, of course, includes chemical cleaning equipment which would not be required on the large-scale plant for 90 or 95 per cent purity. The type of equipment used in making oxygen is familiar to all steel mill operators, particularly to those with by-product coke and benzol plants.

The maintenance on our oxygen plant consists chiefly in: 1. periodic inspection and cleaning of the valves of the 3-stage reciprocating air compressors; 2. replenishing of the caustic soda solution on the spray towers, also repacking the caustic soda pumps when required; 3. operation of activated alumina driers; 4. maintenance of distillation columns; 5. maintaining of packing and

plunger rods on the liquid oxygen pumps (these pumps require repacking every 700 to 1000 hours).

In general our experiences indicated that with the operation of this high-purity small oxygen plant, the operation of a large scale 90 to 95 per cent pure oxygen plant should offer no difficult problems in either maintenance or operation.

F. Janecek: There is one question that I would like to ask Mr. Conway. All the discussion has been on 99½ per cent purity. Is that necessary for either open hearth use or blast furnace use? What would be the cost at, say, 50 per cent oxygen enrichment or a 50 per cent purity plant?

M. J. Conway: I am glad that question was asked. I mentioned in the first part of my talk that the pilot plant was designed to produce 99.5 per cent purity oxygen at the rate of six tons per day; however, the power input of 14 kw per 1000 cubic feet applies to 90 to 95 per cent purity oxygen. The estimated cost of $2.50 per ton of 90 to 95 per cent purity oxygen applies to plants producing 1000 tons or more daily, with power costs not exceeding 5 mils per kw.

F. Janecek: That answers the question partially, but instead of 90 to 95 per cent purity plant, what would the power cost be at 50 per cent purity?

M. J. Conway: The answer to your second question is that it is not economical to manufacture oxygen having a purity under 85 per cent. Therefore, the best practice is to produce 90 to 95 per cent purity oxygen and mix this product with air to bring the oxygen content of the enriched blast up to the desired 50 per cent. If this is done with 90 per cent purity oxygen, which has been produced at $2.50 per ton, then by using round figures, adding 0.6 ton of oxygen to one ton of blast would produce 1.6 tons of blast enriched to 50 per cent oxygen content at a cost of 94 cents per ton of enriched blast.

A. J. Fisher: Mr. Conway discussed his plan in terms of kilowatts. I would like to ask this question, "Suppose that the main drive on his plant is turbine driven by steam at 850 pounds, 900 degrees temperature, what would be the pounds of steam required per ton of oxygen?"

M. J. Conway: Mr. Fisher's question is one of comparison of power. Probably the best purpose will be served by stating that in large plants producing 90 to 95 per cent purity oxygen, the power requirement is 450 bhp hr per ton of oxygen produced or around 14 kw per 1000 cubic feet. This power input will be slightly increased as the purity is increased.

C. E. Agnew: I have never used furnace blast enriched with oxygen but I would like to introduce this thought. While there is not any question that the introduction of oxygen into the blast will generate more heat in the furnace hearth than can be generated with the natural blast, the commercial, or practical, value of that heat is contingent upon your ability to use it after you have it. We have learned in the last few years that the beneficiation of the air blast by the reduction of moisture contained therein has not always been beneficial to the furnace operation. That method of air beneficiation also makes more heat available in the furnace hearth. I do not mean to be critical of the use of oxygen; I believe it is a logical step, but I also believe the step must come in its proper order.

In short, the ability to use more heat in the hearth and bosh is contingent upon the character of the raw materials which are charged into the furnace. There is not any purpose in generating more heat in the furnace hearth unless you can use it and you cannot use it unless you deliver additional material to the hearth to consume it. With the naturally lean soft ores, the operating problem is the preparation of the raw materials in the shaft of the furnace for their smelting in the hearth and bosh of the furnace. Throughout the industry, the furnaces using natural soft ores do not, and can not, use as high blast temperatures as the eastern furnaces where sintered concentrates are used, indicating that the heat requirements, and limitation in consumption, of the hearth and bosh are determined by the material preparation capacity of the furnace shaft.

Mr. Conway has given figures indicating the benefits obtained in some European furnace operations from the use of blast enriched with oxygen. I would like to ask Mr. Conway if he is familiar with the character of the ores used in those operations, if they were hard ores free from volatile matter. Many of the European ores are hard lump while many of our ores are soft and earthy.

M. J. Conway: I do not have the European iron ore analysis with me, but by referring to the article in Metallurgia of June 1944, those ore analyses are given and can be readily compared to the iron ore analysis in this country.

C. E. Agnew: The only thought I wanted to introduce is the belief that the character of the ore used is an important factor in the benefits to be expected from enriching the blast with oxygen.

M. J. Conway: That is correct, when measuring relative benefits.

N. A. Spector: I was connected for a long while during the war with the development of some of these mobile units that Mr. Conway spoke about. I noticed on the flow sheet that the reversing exchanger unit is, as far as I saw it, a 3-passage unit, one each for air, nitrogen and oxygen. It was later said that the unbalance stream passed up through the center. That would necessitate four passages.

Also, if the author would care to comment, I would be interested in some details of the exchanger. I know that the development as a whole required rather ingenious design, and if he has any general statements to make regarding the exchanger in use I would like to hear them.

M. J. Conway: Mr. Spector, your reference to the omission of the fourth passage in the exchanger illustrated with the flowsheet is correct. However, it is a detail which does not detract from the main purpose of the flowsheet and it has been amply dealt with in the process description.

I regret that I do not have an illustration of the latest exchanger tubes at this time, but, I can say that the heat transfer surface has been substantially increased on both sides of the tube, and it is a considerable improvement over the generally accepted exchanger for this purpose.

F. E. Kling: Answering Mr. Agnew's question, the output of a furnace is increased and the coke consump-

tion decreased by enriching the blast with oxygen. There are also other advantages, i.e., the furnace works smoother as the amount of gas is decreased, offering less resistance to the downward movement of the stock. The sensible heat of the gas is utilized better, resulting in lower top temperature, which is especially noticeable when making ferromanganese and high silicon iron. The yield of ferromanganese is higher, as less manganese is lost in the slag. This is due to the greater alkalinity of the slag, made possible by the higher temperature in the hearth. The operation of a furnace can be regulated readily by varying the amount of oxygen in the blast.

Results obtained with a 60 ton experimental furnace in Germany, described by W. Lennings in "Stahl und Eisen" in May 1935, indicate that the economy of using oxygen is most pronounced in furnaces consuming large amounts of coke. Producing ferromanganese, the output was increased 14 to 20 per cent, using blast with 30 per cent oxygen. Saving in coke was 800 lb per net ton. Yield of manganese was 7 to 10 per cent greater. The top temperature dropped from 1175 F to 780 F. The volume of gas was reduced 40 per cent.

The cost of the oxygen plant would partially be made up by smaller blowing capacity, smaller stoves and gas cleaning apparatus.

H. S. Hall: We use probably 12 to 15 million feet of 99½ per cent oxygen a month. I would like to ask Mr. Conway if it is possible in a plant producing 90 to 95 per cent to also produce 99½ per cent oxygen.

M. J. Conway: Replying to Mr. Hall's question, methods have been devised, whereby a certain percentage of the oxygen product can be obtained as 99.5 per cent purity in a separate stream, with the larger oxygen stream being 90 to 95 per cent purity.

The relative volume of the 99.5 per cent purity oxygen, compared to the total oxygen product, is the deciding factor as to whether it is more economical to manufacture a total product of 99.5 per cent purity, or design the plant to produce two oxygen stream of different purity.

K. C. McCutcheon: One of the more intriguing charts which Mr. Conway has presented is the one which gives the relations between cost per thousand cu ft and dollars per ton, as these charts stop at $1 per thousand cu ft which is a figure considerably below those which we are accustomed to using. I would like to ask Mr. Conway the following questions:

Are the charted costs developed for plants for manufacturing gasoline from natural gas, or are they completely divorced from this and simply for those making 92 to 95 per cent oxygen?

Have the following been included in these costs, capital expenditure for boilers for steam generation, and for generators for electric power to be used?

Can you state what saving has been made in cost of chemicals which in the standard plant are used for purification of the oxygen stream?

M. J. Conway: Replying to the questions by Mr. McCutcheon, the charted costs are applicable to any oxygen plant generating 90 to 95 per cent purity oxygen, without reference to the subsequent use of the oxygen.

Capital expenditures for steam generation and electric power plant are automatically taken care of in the cost of power. An average figure of 5 mils per kw has been used for illustration purposes. Power costs, of course vary with geography and local conditions, but I believe that 5 mils is a fair average figure.

Regarding the savings made due to the process described not requiring chemical clean-up, this again is a variable, depending on type of plant and local conditions. This operation can cost 3 cents per 1000 cubic feet of oxygen manufactured. The average for the industry is probably 2 cents per 1000 cubic feet.

Commenting on Mr. Kling's timely remarks, the chief object of my paper was to describe the process for manufacturing cheap oxygen. The availability of cheap oxygen opens up new uses and applications which cannot be entirely appraised at the moment.

Experiments are being made by at least fifteen steel companies, using oxygen in both the open hearth and blast furnace operation. Some of these experiments have been of sufficient duration to prove conclusively that time and cost can be improved and in some cases quality and metallic yield improved. We agree with Mr. Kling that the application of oxygen enriched blast in ferromanganese furnace operation, will result in sizable coke savings and increased production.

An Engineering "Must"

THE ANNUAL SPRING CONFERENCE

UNDER AUSPICES OF

THE ROLLING MILL COMMITTEE

ASSOCIATION OF IRON AND STEEL ENGINEERS

HOTEL BENJAMIN FRANKLIN

MAY 26 AND 27, 1947

PHILADELPHIA, PENNSYLVANIA

CONTINUOUS HOT GALVANIZING OF STRIP

. . . . the newer methods of galvanizing, with their highly adherent coatings, should create new markets for galvanized material . . . .

BY E. A. MATTESON

AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

▲ A sheet galvanizing line usually consists of a feed table, an acid dip, a coating unit, a cooling conveyor, a leveller and piler. The coating unit is made up of a kettle with a suitable heating system, a pair of entry or flux rolls, a flux box, one or two pairs of bottom rolls, and a pair of exit rolls with guides between the various sets of rolls. The flux is a modern witches brew as it seems to take a certain amount of witchcraft to make it. Its basic ingredient is salammoniac. Every galvanizer seems to have his pet concoction, and, peculiarly enough, most of them work. The sheet is entered through the acid dip into the flux box through the zinc bath, out between the exit rolls, and then onto the cooling conveyor, through the leveller, and then inspected and piled.

If we take a conventional sheet galvanizing machine and run extra long sheets we would in effect be coating strip. If these sheets are sufficiently long to be called strip, and we must coil them in order to handle them, and then weld the successive ends of the coils together as we coat them, we are continuously galvanizing. Several units are being run at the present time in this manner. A pay-off reel is installed ahead of a muriatic tank and a shear placed beyond the pot. The ends of the coils are spot welded together. This necessitates stopping the line while welding, as no provision is made to store a sufficient loop to allow for the welding time. A short length, approximately twelve feet, is spoiled each time the line is stopped. The galvanizing rig may be left alone or the bottom rolls removed and one or two idler rolls used. The later method is preferred by some because a slight amount of tension can then be used through the pot, which eliminates much of the guiding problem. Opinions are divided as to whether bottom rolls are required or whether idler rolls are all that are necessary. There is a slight difference in appearance of the opposite sides when idler or sinker rolls are used, but there seems to be no appreciable difference in the weight or quality of the coating. A shear and gauger table is used in order to use present cooling and levelling equipment. Recoiling would require additional handling as few if any fabricators or warehouses are able to handle coiled material at present.

Perhaps the greatest advantage in galvanizing in this manner is the increase in yield due to the absence of heavy front ends and list ends which are common to galvanized sheets. This improves the yield by several per cent. A slight increase in production is noticed due to the elimination of lost time between sheets. This amounts to two or three per cent. More uniform coating weights can be obtained as the level of the pool at the exit rolls is more nearly constant. With sheets the rolls pump up a large supply of metal during the time no sheet is present. The speed of the unit can be stepped up slightly when running roofing grades of material. This is true even though the increase in speed may reduce the uniformity and quality of coating, it still will be a good average for this class of product. In better grades no increase in speed has been accomplished.

So far we have dealt only with adapting present sheet units for continuous galvanizing. A new line for galvanizing coils continuously by conventional and accepted methods would be designed somewhat differently. A typical layout would consist of a pay-off reel, a pinch roll, a shear, a welder (either flash or seam, depending on the gauges), a looping pit or tower, a pinch roll, a muriatic dip, a coating unit, a large drum and pinch roll located approximately eighteen feet above the exit rolls, a cooling tower, a shearing unit, and a leveller and piler. If desired a bridle roll set and a tension reel for handling coils can be added. The coils can be shipped as they are or can be cut into sheets on a separate shearing unit. The shearing unit in the line can be eliminated if this latter method is used. The coating unit would be somewhat changed as only entry rolls, a sinker roll and exit rolls are required. A simple rig for the exit rolls will be used in place of the cumbersome housings now used and a simple drive for the exit and entry rolls. By taking the strip up vertically from the exit rolls, a more uniform coating on both sides is achieved and the rolls can be more easily changed. The

Presented before AISE Chicago District Section Meeting, April 16, 1946

loop will allow the line to run at a constant speed even while welding. This design is predicated on the use of cold reduced, cleaned, annealed, and temper rolled strip. If it is desired to coat hot rolled strip additional preparation of the surface will be required. It may be necessary to put a scrubber in the continuous pickler and coat the strip with an emulsion of some kind to prevent its rusting prior to coating. A cleaning unit would then be necessary in the galvanizing line to remove this protective coating.

Other additions to such a line would preferably include an alkali cleaner, which could be either a hot alkali bath or an electrolytic cleaner. A scrubber should then be used after the cleaner. The muriatic pickle can be considerably accelerated by the use of low voltage current either as an anodic or cathodic application or as a combination of both. More uniform preparation of the surface will undoubtedly result.

If we increase the galvanizing speed many problems develop. It will be difficult to keep the coating weight down and uniform. It will be necessary to maintain the metal level absolutely uniform. A metal level control must be used and a constant supply of new metal must be available. This should be done electrically and/or mechanically as far as possible to eliminate manual control. With higher speeds, we will undoubtedly experience a runback of the coating beyond the exit rolls. This might be eliminated to some extent by rapid chilling at this point. Too rapid chilling may also present a new problem by increasing the stiffness of the base metal. This strange condition is often noticed when coating cold reduced material. Even though the Rockwell hardness has not changed, the resistance to forming is stronger and the spring back greater when the material is cooled too suddenly. There is without question a very definite limit to the speed possible while we still use exit rolls to control the coating. Heating also becomes a problem with higher speeds as it is very easy to cause a freeze-up at the flux box. Preheating in some form may be used. Then the conventional fluxing becomes impossible and other new ideas must be developed.

There are several non-conventional methods in various stages of development. One line now in production utilizes a gas pickling furnace. A highly adherent coating has been produced by this method. However, it is not generally known just how far this method can be developed within the bounds of economical operation. The Armco zinc grip is produced by another non-conventional method which employs a furnace for surface preparation. Other methods using furnaces are in the development stage. A great advantage in using a furnace is that normalizing may be accomplished in the line. This allows the use of cold reduced steel directly from the tandem mill. The steps of cleaning, annealing and temper rolling are not required. Flux problems are eliminated as the strip is protected by an inert atmosphere until it is immersed in the zinc bath. These methods require a large capital investment with resulting increased operating costs. The production speed is limited by the capacity of the furnace. The furnaces must therefore be long and the line requires a great amount of space.

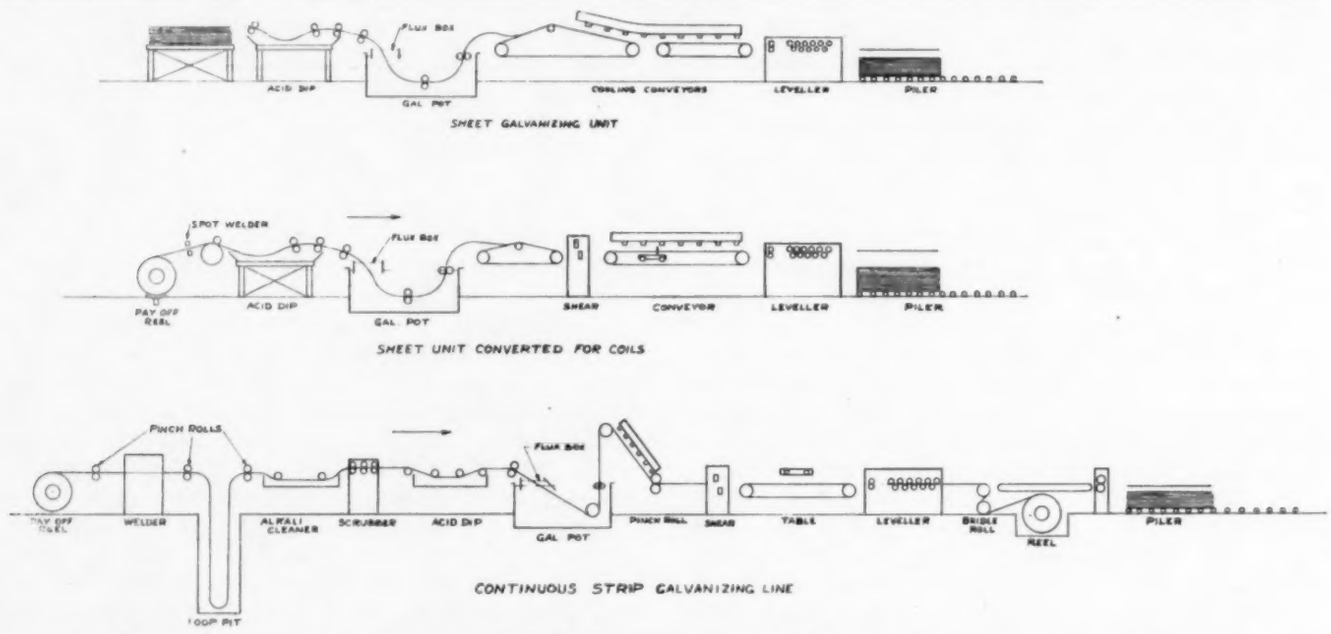


Figure 1 — The layout of a continuous strip galvanizing line may involve several additional operations to those used in an ordinary sheet galvanizing unit.

These newer methods with their highly adherent coatings will create new markets for galvanized material, and we should see several new lines added in the near future. The large tonnage requirements for galvanized steel still lie within roofing and metal shop requirements where only normal adherence is necessary. Therefore, we believe that many continuous galvanizing lines following closer to conventional practices will be required and installed.

DISCUSSION

PRESENTED BY

E. J. POSSELT, Engineering Department, Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin

E. A. MATTESON, Aetna-Standard Engineering Company, Youngstown, Ohio

F. W. BROWN, Superintendent, Galvanizing Department, Inland Steel Company, East Chicago, Indiana

H. W. NEBLETT, Special Engineer, Inland Steel Company, East Chicago, Indiana

W. C. GREENLEAF, Metallurgical Department, Youngstown Sheet and Tube Company, East Chicago, Indiana.

PERRY WRAY, General Foreman, Galvanizing Department, Carnegie-Illinois Steel Corporation, Gary, Indiana

H. O. LINDE, Carnegie-Illinois Steel Corporation, Gary Sheet and Tin Mill, Gary, Indiana

L. F. McCAFFREY, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

L. A. TERRY, Superintendent Power and Electric, National Tube Company, Gary, Indiana

A. THURMAN, Aetna-Standard Engineering Company, Youngstown, Ohio

J. M. BIALOSKY, Associate Metallurgist, Armour Research Foundation, Illinois Institute of Technology, Chicago, Illinois

R. V. CORDINGLEY, Tin Plate Metallurgist, Youngstown Sheet and Tube Company, East Chicago, Indiana

W. J. TUNNY, Assistant Electrical Engineer, Youngstown Sheet and Tube Company, East Chicago, Indiana

E. J. Posselt: I would like to know whether I understood correctly that the coating is increased as the speed is increased.

E. A. Matteson: That is correct; this can be demonstrated by the use of Figure 2 which shows a cross section of a pair of exit rolls with the sheet being pulled up through the rolls. Note the pool of metal at the bite of the rolls. The metal level is kept somewhere near the center line of the exit rolls. These rolls are grooved, with some of the grooves spiraling from each end to the center, others being merely concentric, or circular rings. The depth of the grooves varies, depending on the type of coating and weight of coating required. As these rolls turn, they pump this metal up into the pool. The final regulation of the weight of the coating is partly due to the surface tension of the metal in this pool. The rolls are trying to pull the metal away from the sheet, the sheet is trying to pull the metal up. As the speed is increased the force along the sheet increases and the amount of metal carried on the sheet becomes greater.

F. W. Brown: The rolls seem to be the bottleneck both on your conventional galvanizing and the new strip idea, with regard to speed, in that speed increases your coating. It is the problem as long as you use rolls. It is possible to use wipers and eliminate the spangles on your sheet, and get the trade to understand that the sheet had just as much coating on it and just as long a life, but this is a hard job today. They almost want to tell you how many spangles they want. However, the wiper probably would give you just as good a sheet and then you could attain real speed.

E. A. Matteson: Mr. Brown has answered his own question. It is a problem to get the trade to accept a sheet without a spangle. The farmer likes a spangle on his sheet. It is going to take a lot of promotion work in the sales department to create a demand for plain galvanized sheets. There is no question, however, that wipers will allow a considerable increase in speed.

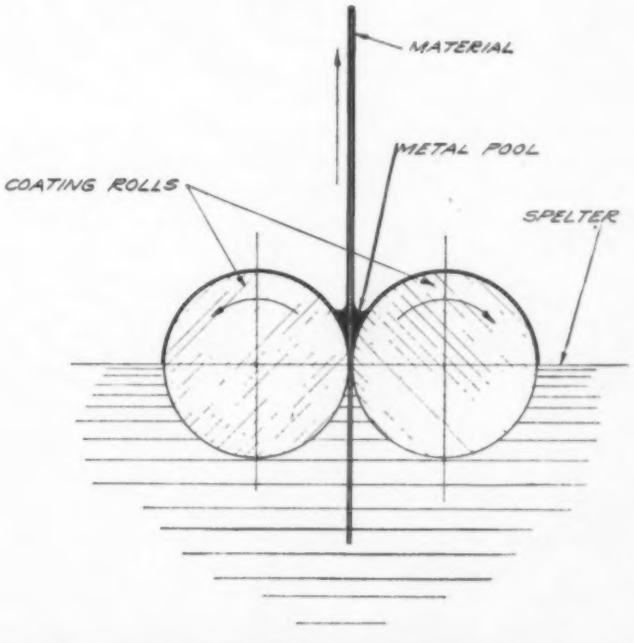
H. W. Neblett: Would it not be possible to increase the speed, if cooling is the only thing which governs spangling; if regulation of the cooling by use of a longer cooling bed would not give you the same result. In other words, if you had a cooling bed, say, twice as long, with regulation of the air input, and if the speed were twice as high, wouldn't you come out with about the same quality of product?

E. A. Matteson: Yes, Mr. Neblett, the spangle can be controlled by proper regulation of the cooling cycle, but this does not answer the problem of the increased coating thickness. The material can be properly cooled by controlling the strip speed and the volume of cooling air over a longer cooling zone, and that undoubtedly will have to be done in a continuous line.

W. C. Greenleaf: What is the advantage of the method you speak of, that of welding sheets together, over the individual sheet method? I don't see that it has any advantage at all, it is not a continuous strip. You have the operation of welding and then the shearing of the welds afterwards.

E. A. Matteson: In the lines that have been converted to coils at present, usually they do shear into sheets. The advantage is in the increase in yield. The

Figure 2 — The faster the speed, the greater is the tendency to pull metal from the pool at the top of the coating rolls, and consequently, the thicker is the zinc coating.



metal loss from heavy ends and edges amounts to as high as eight to ten per cent. There is an appreciable saving in the amount of zinc used. There is also the increase in efficiency, because on a sheet machine there is anywhere from one foot to three feet between sheets. The strip is running constantly except at the time in the weld, and by placing a looping pit ahead of the line, the need for stopping can be eliminated, thereby producing a lower cost material.

W. C. Greenleaf: I can see that in the continuous coil or strip method where full-hard, cold-reduced coils are brought directly from the cold reduction mill and annealed-galvanized in a continuous strip process there would be many production advantages. Is that the Sendzimir process?

E. A. Matteson: The Sendzimir is one of the processes. There are two others.

W. C. Greenleaf: Do they all use a two furnace continuous anneal — say first the slightly oxidizing anneal and then the higher temperature anneal in reducing atmosphere such as produced by dissociated ammonia?

E. A. Matteson: The Sendzimir uses the oxidizing method; the other methods do not, but the results are similar.

Perry Wray: I note that you mentioned the difference in appearance between top and bottom where you went under the hold-down roll. Is there any increase in that difference where you have one or two hold-down rolls?

E. A. Matteson: This difference seems to be less when a large diameter hold-down roll is used as compared to the results with the small eight-inch rolls which have been used in some plants. This might be due to the fact that the small eight-inch roll is harder to turn, and it is possible that there might be a little slippage between the small hold-down roll and the strip itself.

Perry Wray: You don't attribute that to any deformation in your sheet as you come around that sharp turn on the eight-inch roll?

E. A. Matteson: That could be true on heavier gauges.

H. O. Linde: I wonder whether surface preparation through treating in heating furnaces will help increase the speed of the galvanizing process.

E. A. Matteson: Mr. Linde has asked a very interesting question, with a lot of possibilities. First, there is no question that the surface preparation will help increase the speed. We will set aside the furnace for a moment, and speak merely of cleaning. The cleaner the surface of the metal before it reaches the pot, the less heat is going to be required in the pot. The cleaner the sheet the sooner the sheet will reach coating temperature and the faster it can be run through the pot.

Now to consider the furnace method; the preparation in the furnace also heats the strip to a coating temperature. It is introduced to the metal bath at approximately the temperature of the bath itself. Therefore, the strip does not have to be heated in the zinc bath.

Besides this, these methods, by use of an inert gas or some other atmosphere, have done away with the use of flux, and by eliminating the flux it is possible to change the alloy of the pot, particularly by adding quantities of aluminum. These small quantities of aluminum help to reduce the surface tension of the zinc, and the strip can run at higher speed without unduly increasing the weight of the coating.

L. F. McCaffrey: There was one thing I didn't quite understand. That was when you talked to Mr. Linde about the preparation, you said that by proper preparation you could increase the speed of the line, and prior to that time you said that the increase in the speed would build up the metal at the exit rolls. Wouldn't that still build up at the exit rolls, creating a pool of metal there that would increase your coating? How would the preparation of steel allow you to speed up the line?

E. A. Matteson: The preparation of the surface by means of a furnace and a controlled atmosphere allows the use of this atmosphere as a flux rather than using a sal-ammoniac wet flux, as is done in the conventional pot, and thereby aluminum is used in the mixture of zinc. This reduces to some extent the surface tension of the zinc, and the zinc cannot pull up as high in the pool as it will without the aluminum mixture.

L. F. McCaffrey: Does that have any effect on the spangle?

E. A. Matteson: Yes, it does. The spangle will be brighter. The entire coating will be brighter if there is aluminum in the coating metal.

L. F. McCaffrey: Most people wanted to use some aluminum during the war when other materials were hard to get, to add to the spangle. Would that be true?

E. A. Matteson: I don't believe so in sheet pots, because aluminum in a sheet pot will produce aluminum oxide on the exit rolls which would cause oxide spots and an unsalable sheet. During the war, with the shortage of tin, there was a greater increase in the use of antimony than aluminum.

W. C. Greenleaf: I would like to ask a question on the cleaning process, how to accelerate the cleaning to get away from the possibility of blisters, using your muriatic acid cleaning solution. You mentioned electrolytic cleaning to accelerate that process. If you have a questionable steel quality, excessive time in the acid may produce blisters.

E. A. Matteson: What I had in mind there was alkali cleaning. If the surface is cleaned only by submersion in hot alkali, a long tank is required. By using electrolytic cleaning, the tank length can be cut by about two thirds. There have been some developments in the use of electrolytic cleaning with muriatic acid, but it has not, so far as I know, been used in galvanizing, but only with tin plate.

L. A. Terry: Would it be possible to electrogalvanize instead of hot galvanize the strip?

E. A. Matteson: Some electrogalvanizing is being done, as you undoubtedly know. Weirton are advertising their Weirzin, and Republic has tried some electrogalvanizing. This work has been done on converted electrolytic tinning lines. The great increase in current density required to electro-deposit zinc over that of tin, requires that the line be run considerably slower than the tin plate lines are run. Consequently, the power input is high, and the cost of operation is high. The present units are depositing a very light coating of zinc. This is not put on for real protection, except that it

will react in a bonderite solution much better than a plain iron or steel surface, and the bonderite then gives a more permanent protection for the material. It also receives paint much better. But to electrogalvanize to produce a weight of coating that would give permanent protection such as offered by conventional galvanizing would be very expensive.

A. Thurman: My principal connection with continuous galvanizing lines to date has been in the application of the electrical equipment. Many of you are familiar with the recent developments in electrolytic tinning lines. The problem of driving the continuous galvanizing line is very similar; however, there are additional difficulties involved in controlling the tension, especially when a furnace is involved. Due to the high strip temperature it is essential that the strip tension does not exceed approximately one thousand pounds per square inch while it is being pulled through the furnace. There are several ways in which this problem can be approached. One way which has been done is to use the ordinary tension control between the furnace entry rolls and the drag-out rolls which pull the strip through the furnace and the galvanizing pot. That means of control provides the required tension through the furnace, and at the same time maintains constant tension through the coating unit, which is also desirable. Other methods are usually based on the principle of supporting a weight on a roll which floats on the strip, to provide tension in proportion to the amount of weight supported by the roll. Some means of automatic loop control are used to maintain the position of the floating weight.

There are other interesting electrical problems in the line. One lies in the possibility of using electric heating for the galvanizing pot; since the heating units can be placed in intimate contact with the galvanizing pot, they are easily insulated, and the heat loss can be cut to a minimum. Another is in the special loop control sometimes used on continuous lines; the electrical installation of the line also presents interesting problems.

Those are the principal problems unique to galvanizing lines. Most of the others are encountered in other processing lines.

J. M. Bialosky: It is my understanding that the purpose of the exit rolls is to pull the sheet through the pot. With the new modification of the design described where the drive rolls are applied above the pot, are the exit rolls necessary? You can use aluminum to maintain surface tension.

E. A. Matteson: The exit rolls also act to control the weight of the coating at present, and they can not be eliminated without running the line very slowly.

The old Austrian method of making galvanized sheets, one of the very superior methods in about 1870, used aluminum in the bath, even though it did not produce the uniformity of product which is obtained today. The sheet was dropped into a deep pot endwise, it was then lifted to the surface of the metal, and then pulled up into the air very slowly. In that way, the surface tension would regulate the weight of coating, and it was possible to hold it down to as low as two ounces or lower per square foot. However, the speed was about six to eight feet a minute. Faster than that, the coating would go up to five, six, and even eight ounces per square foot, which is much too heavy.

Thus the exit rolls are required to control the weight of coating, or, as Mr. Brown has suggested, wipers can be used to wipe off the metal. The unfortunate part, as Mr. Brown also pointed out, is that in using wipers there is no spangle, no pretty flowers, and the sales department has a very difficult time trying to make their customers believe it's a galvanized sheet.

F. W. Brown: You mentioned that with the exit rolls not being covered up, there is no flux. Don't you get some zinc oxidation there on the rolls which would carry onto the strip?

E. A. Matteson: There isn't nearly as much as one might think. It is best, however, to use one of the top packs, the chemical packs, near the exit rolls, and that then only allows the metal on the roll itself to be exposed to the air, and the roll does not pick up oxides from the balance of the surface. Scrapers are also used on the rolls. Otherwise there would be oxides imbedded in the surface of the sheet.

R. V. Cordingley: Everyone is interested in the speed of this line, there have been so many questions on it tonight. I was wondering if, instead of putting all that work on one set of exit rolls, it would be possible to have some type of a liquid medium at the exit end of the pot, where you would have two or three pairs of exit rolls, and then, by controlling the pressure on those rolls, the number of grooves, the depth of those grooves and the taper of your rolls, control the coating a little bit better than with only one set.

E. A. Matteson: That is an interesting possibility. As far as I know, it has not been investigated; nor offhand, do I know just what medium could be put over these various sets of exit rolls which would make the machine act something like a tinning machine. There is some possibility that without the use of aluminum in the bath, more than one set of exit rolls could be used in a deep bath of zinc chloride. It would then be possible to keep the zinc chloride up to a high enough temperature so that the metal wouldn't start freezing as it left the first pair of rolls, and the second pair of rolls would still be effective, or even a third pair if it were found necessary.

These are all possibilities, but considerable development is still required. I don't know if multiple sets of exit rolls have been used. Perhaps, Mr. F. W. Brown knows something about this possibility.

F. W. Brown: No. I have often thought of that, it would be an ideal condition. The only thing is that by the time you get to your second or third pair of rolls, your metals begin to freeze and you have a heavy, thick coating of zinc on your rolls. If you could control that, it would be a solution to your bottleneck on the high speed electric rolls.

E. A. Matteson: You are correct, and that is why I suggested the hot bath of straight zinc chloride which could be kept at a high enough temperature to keep the zinc molten. But with zinc chloride we could not use aluminum in any way that I know of at present.

F. W. Brown: May I ask one more question? We have now galvanized the strip and we come to a very important point as far as the customer's standpoint is

concerned. Where would you suggest the inspection of strip?

E. A. Matteson: It can be done right in the line, and we are proposing methods at the present time so that the sheet can be examined after the shearing unit (we will consider that the line has a shearing unit), rejected into a reject piler, if it is a reject, or passed onto a prime piler if it is a prime sheet. Those are all mechanical possibilities.

You engineers tell us what you want to do and we shall attempt to work it out mechanically. We are doing more and more of those jobs in the line all the time. If we recoil material, of course, it is rather difficult to get good inspection, and even if a bad spot is detected, it could not be cut out of the strip.

W. J. Tunny: What number of feet per minute is most practical in continuous operation in galvanizing strip?

E. A. Matteson: The speed that the pot is run is dependent on the type of coat, weight of coating, and gauge of the material. There has been very little increase in speed in converting a conventional sheet galvanizing practice to strip. Speeds will run anywhere from 15 feet up to possibly 120 feet per minute. I believe it is going to be possible to run up to 150 or 160 feet per minute in the near future. Where we go from there is anybody's guess.

ASSOCIATION OF IRON AND STEEL ENGINEERS

DISTRICT SECTION MEETINGS

BIRMINGHAM — APRIL 5, 1947

INSPECTION TRIP AND TECHNICAL SESSION PROGRAM

10:00 a.m. — Inspection trip to Atlantic Steel Company, Atlanta, Georgia

12:30 p.m. — Lunch, Plant Cafeteria

2:00 p.m. — Technical Session — Plant Auditorium

"Modern Electrical Control for Wire Drawing Machinery"— by O. M. Bundy, assistant chief engineer, Clark Controller Company.

6:30 p.m. — Social Hour and Dinner, Henry Grady Hotel, Atlanta, Georgia.

BIRMINGHAM — APRIL 28, 1947

"Southern Blast Furnace Operations" — By Fred Osborne, general superintendent, Sloss-Sheffield Steel and Iron Company, Birmingham, Alabama.

BUFFALO — APRIL 8, 1947

"The Use of Oxygen in the Open Hearth Furnace" — By E. T. W. Bailey, combustion engineer, Steel Company of Canada, Ltd., Hamilton, Ontario.

Dinner and Meeting at Rosa Villa Inn, Welland, Ontario.

DETROIT — APRIL 8, 1947

"Applications of Some Organic Chemicals in the Iron and Steel Industry" — By Dr. A. J. Napier, Dacar Chemical Company, Pittsburgh, Pennsylvania.

PHILADELPHIA — APRIL 5, 1947

"Jacking Up the Shell in No. 5 Blast Furnace" — By L. F. Coffin, Bethlehem Steel Company.

"The Operation and Maintenance of Automatic Preset Screwdown Control as Applied to Steel Mills" — By R. G. Uhler and Joseph F. Skalka, Lukens Steel Company.

"Total Analysis of Brush Operation" — By William Siebenmorgan, Electro-Service, Inc.

"Some Factors Affecting Bearing Life" — By William A. Smiley, Bethlehem Steel Company.

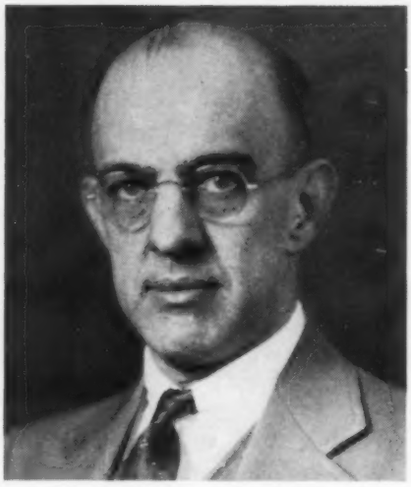
"Various Applications of Resistance Welding" — By W. J. Farrell, Sciaky Brothers, Inc.

PITTSBURGH — APRIL 14, 1947

Maintenance Symposium.

DISCUSSION OF MILL MOTOR STANDARDS

. . . . few recent motor developments affect the steel mill electrical man as much as the proposal to reduce the frames for each mill motor rating by one frame size . . . .



FRANK W. CRAMER

By FRANK W. CRAMER

CHAIRMAN

AISE STANDARDIZATION COMMITTEE

Presented before AISE Annual Convention, Cleveland, Ohio, October 1, 1946

▲ THE 1907-1908 proceedings of the AISE contain several papers relating to the first so-called mill type motors, which were the Crocker-Wheeler W series. These motors were the answer to the steel industry's demand for something better than the railway type motors then in use on cranes and mill auxiliaries. In the years following, the General Electric Company introduced its MD series and the Westinghouse Company the MT series. These three motor lines had different horsepower ratings and different speeds, which mill operators thought should be standardized.

In a paper delivered by the late W. T. Snyder in March 1918, a plea was made for users and manufacturers of mill type motors to get together and standardize not only the ratings and speeds, but also the principal dimensions of the motors. Although everybody agreed this should be done, no tangible results came from the plea until 1926, when an AISE committee, under the chairmanship of A. C. Cummins, recommended the principal dimensions for seven interchangeable frame sizes with the following standard ratings:

Frame	Mill Rating		Crane Rating	
	Hp	Speed, rpm	Hp	Speed, rpm
A	7½	800	10	690
B	10	725	13	625
C	15	650	20	560
D	25	575	33	495
E	35	525	45	455
F	50	500	65	430
G	75	475	100	410

This recommendation was adopted, and the three motor manufacturers agreed to adhere to these ratings and dimensions when new designs were brought out. These were so-called long motors and had sleeve bearings. The final report including the final outline dimensions was published in the *Iron and Steel Engineer* for January, 1929.

During the next ten years anti-friction bearings were developed for use with these motors. There was also a demand for additional frame sizes. In 1940 a committee, whose chairman was the late G. R. Carroll, gave a report recommending the following revisions to the 1926 standards:

1. The standard d-c mill motor of the future is to be the short frame motor.
2. The basic 1 hour, 75 C rise totally enclosed ratings of the standard line are to be as follows: 5 hp, 7½ hp, 10 hp, 15 hp, 25 hp, 35 hp, 50 hp, 75 hp, 100 hp, and 150 hp. The ratings which were added to the 1926 standards were the 5 hp, 100 hp, and 150 hp.

These ratings and the principal dimensions recommended by this committee were adopted in 1940 and are in use today.

It should be noted in passing that, other than changes due to the roller bearings, the principal dimensions of the motors are about the same as those adopted in 1926, and not much different from those in the earlier motors.

As a contrast to this, Figure 1 shows what has happened to horsepower ratings in one line of general purpose motors from 1905 to the present time. It will be noted that the horsepower has been increased fivefold since 1905 and doubled since 1920. This is indicative

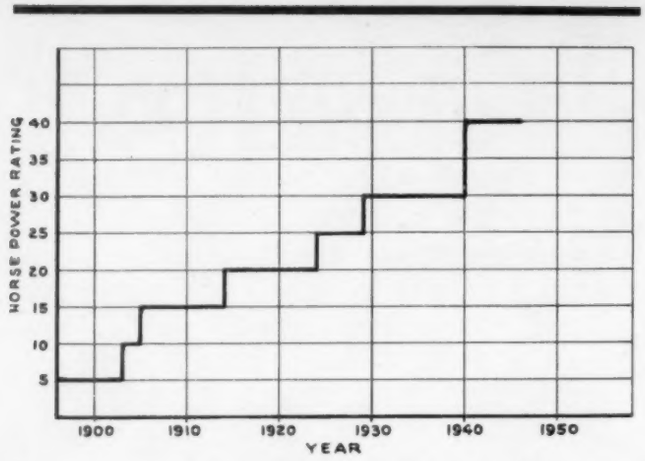


Figure 1 — Improvements in materials and design have increased the output from a motor of a particular frame size about eight times in forty years.

of progress in design and the use of better materials as they become available.

Early in 1946 the Association of Iron and Steel Engineers received a request from the General Electric Company stating that they wished to take advantage of progress in the art of motor design and bring out a new line of mill motors, using the AISE standard frame sizes, but increasing the horsepower in each frame to the rating of the next larger frame. In other words, the electrical characteristics of the present motors would be mounted in a frame whose dimensions are that of the next smaller size. Approval of these new ratings as an AISE standard was requested.

A committee from the AISE met with General Electric Company representatives at the Erie works on May 14, 1946, to see test demonstrations of the new line and to discuss the future of mill type motor design. Following this meeting, the committee agreed that if any changes to existing standards were to be made, an open discussion of the present standards and their relation to future standards should be held.

The following proposal was submitted by the General Electric Company for our consideration:

1. Assignment to the present AISE frame sizes and dimensions, for both the basic and the back geared motors, of the existing horsepower and speed ratings for the next larger AISE frame size.
2. Establish in a frame smaller than the present AISE frame No. 2, one new frame to accommodate the new 5 hp rating.
3. Alter the present standardized bearing sizes to permit shaft diameters suitable for the new proposed higher ratings.
4. Add to the present list of standard motors one having the 200 hp one hour enclosed rating in the AISE frame No. 18.
5. Standardization of the 20 degree stub tooth form of gearing.

Table I has been prepared to show what this means in percentage increase in horsepower for the different frame sizes. This table shows that the greatest increase would come in frame No. 6 where a 73.8 per cent increase in horsepower would result. The design engineers stated that due to better materials, increased ventilation, and improved design, the proposed motors at the new rating would not have an increase in the temperature rise and would have better overall efficiencies than existing motors.

In the proposed line of motors, the speeds would also be changed from the existing speed for the rated horsepower in the present frame size to the rated speeds of the next larger frame size. Table No. II has been prepared from Westinghouse catalogue curves to show this relation. From this tabulation it can be seen that for the same horsepower the new motor will run faster than the existing motor. For example, the present frame 10 motor with a rated speed at 35 hp of 525 rpm would be replaced by a motor rated at 50 hp whose speed at 50 hp would be 500 rpm, but whose speed at 35 hp would be 570 rpm or a slight increase in speed for the old rating. This is based on the assumption that the new speed curves will be similar to the old speed curves through the central part of their range. In case of replacement of the present motor with the proposed motor on an existing installation, there will be a load increase on the new motor due to this speed increase. It should also be noted that on the light loads there may be some danger of runaway speeds; this problem may arise when making motor replacements in existing overloaded operations where the light

TABLE I

COMPARISON OF EXISTING AND PROPOSED RATINGS FOR MILL TYPE MOTORS

Frame	Existing hp rating		Proposed hp rating		Per cent increase in rating	
	½ Hr	1 Hr	½ Hr	1 Hr	½ Hr	1 Hr
2	6½	5	10	7½	54	50
3	10	7½	13½	10	35	33.3
4	13½	10	19	15	40.7	50
6	19	15	33	25	73.8	66.6
8	33	25	45	35	36.4	40
10	45	35	65	50	44.5	43
12	65	50	100	75	54	50
14	100	75	135	100	35	33.3
16	135	100	200	150	48.2	50

loaded condition will have to be considered. A change in gear ratio is one solution to this problem.

The AISE Standardization Committee realizes the seriousness of changing the existing mill type motor standards and also the necessity of recognizing progress in the art of motor design. In order to get a cross section of opinion on this problem, questionnaires were sent to 31 steel mill engineers and manufacturers using these motors in steel mill applications. Answers were not received to two of the questionnaires. The first question on the list was: "Should the principal physical dimensions of mill motors as listed in the AISE standards be retained?"

Twenty-six of the 29 replies answered "yes" to this question. Two other replies were also in favor with the stipulation that if there would be a real gain in performance from changing dimensions such change should be considered. The other answer favored the dimensions of the old MCB type which used to be built by Westinghouse. Several answers carried notations regarding the expense and work that has been required to get the present standard motors installed in their plants, and had very positive objections to any changes in the dimensions.

The second question on the list was: "Do the present ten frame sizes cover your requirements?" Sixteen of the replies stated "yes" without reservation. Thirteen of the replies requested additional sizes as follows:

1. One requested an additional size between 19 and 33 hp, crane rating.

TABLE II

COMPARISON OF SPEEDS FOR GIVEN LOADS ON THE EXISTING AND PROPOSED FRAME SIZES

	Speed in rpm									
Frame	No. 2	No. 3	No. 4	No. 6	No. 8	No. 10	No. 12	No. 14	No. 16	No. 18
Rating	5 hp	7½ hp	10 hp	15 hp	25 hp	35 hp	50 hp	75 hp	100 hp	150 hp
Hp load										
2	1680									
3	1300	1300	1440	1800						
5	900	1010	1010	1310	1240					
7½	660	800	840	1030	1020					
8	610	770	810	990	980					
10		660	725	850	870	960	1440			
15		490	575	650	760	780	880			
18			510	600	700	720	800			
20				555	630	680	730	1100		
25					575	600	660			
30					520	560	600	860	1000	1100
35					490	525	570	780		
40					450	490	535	690	770	
45					420	480	510			
50						440	500	600	670	690
60						400	450	535	590	630
70							420	510	560	580
75							410	475	540	570
80							400	460	520	560
90							375	465	480	520
100								420	460	500
120								395	430	460
150									390	430
175									370	405
200									350	385
250										360
300										340
350										330

TABLE III

USE FACTOR AND RELATIVE MONEY VALUES OF THE TEN AISE FRAME SIZES

Frame No.	Per cent of total	List price 1-1-46	Money value	Per cent of total money value
2	8.5	$ 485	$ 4,122.50	3.8
3	8.1	555	4,495.50	4.2
4	8.2	610	5,002.00	4.7
6	12.0	715	8,580.00	8.1
8	15.2	880	13,376.00	12.7
10	18.1	1,050	19,005.00	18.1
12	16.3	1,300	21,190.00	20.0
14	7.2	1,750	12,600.00	12.7
16	3.2	2,200	7,040.00	6.6
18	3.2	3,025	9,680.00	9.1
	100.0		$105,191.00	100.0

Percentage of back axle motors sold 2 per cent.

2. Five requested a smaller size be added. The majority of these were crane manufacturers who wanted a smaller motor for crane trolleys.
3. One requested an additional size between the 65 and 100 hp crane rating.
4. One requested an additional size of 200 hp, at same time eliminating the No. 3 or 7½ hp size.
5. One requested additional sizes of 200 and 230 hp.
6. Three requested additional sizes of 200, 250, 350 and 500 hp.
7. One wanted the frame sizes extended up to 300 hp.

As a guide to the use of the various sizes of these motors, the information shown in Table III was supplied by the Westinghouse Electric Corporation based on their sales of the ten frame sizes. This table indicates there is an economic problem for the manufacturers if additional frame sizes are required. However, the fact that the great majority of answers indicated satisfaction with the existing range, means that if the larger horsepowers are to be built into the existing frames, a smaller size with the same rating now available in the No. 2 frame will have to be supplied.

The third question on our questionnaire was: "Each of these frames now has five different ratings. Are these all necessary? What ratings do you use for cranes and auxiliary motors?" The answers to this question were as follows:

1. Two use only ½ hour ratings.
2. One uses only the 1 hour rating.
3. One uses the 1 hour and continuous forced ventilation ratings.
4. One uses the 1 hour rating plus curves.
5. Eight use both the ½ and the 1 hour ratings.
6. One uses the ½ hour and 1 hour ratings plus curves.
7. Five use the ½ hour, 1 hour and continuous ratings. (One of these also asked for forced-ventilation ratings.)
8. Two use the ¼ hour, ½ hour, 1 hour and continuous ratings.
9. Seven use all five ratings.
10. One of the answers suggested that time ratings be eliminated, and curves for each frame size be used with sufficient information to determine permissible loading.

There were no comments on the basis of these ratings, which has never been too clearly defined. The half-hour rating does not mean that this loading can be normally kept on for 30 minutes without over heating, nor can the 60 minute rating normally be used for the specified load for 1 hour. What is meant is that if a cold motor is run for 30 minutes at the 30 minute rating, the temperature will rise 75 C. Any further operation will increase the temperature still further. For example, the Frame 12 motor when started cold and run at 65 hp (crane rating), will increase its temperature 75 C in 30 minutes, and go higher if operated longer. The motor can be used on a 65 hp load only intermittently for a longer period of time than 30 minutes, and in this case can be run continuously only about 15 per cent of the time at 65 hp, or at most, ¾ minute out of every five minutes, if the temperature is not to be exceeded. The repeated load cycles must have a duration of five minutes or less. The same principle applies to the one hour rating, in this case 50 hp, where the motor can be operated indefinitely only 22 per cent of the time at 50 hp if temperatures are not to be exceeded. It is interesting here to note that the one hour, 75 C rise rating may be obtained continuously if enough forced ventilation is applied to pass 150 cu ft per min of air for every kilowatt loss in the motor. Few series motors have constant loads, and if the specifications are changed, definite statements should be included as to what the ratings mean. This would give the application engineers more confidence in using, say, a No. 10 frame, crane rating 45 hp, on a hoist if calculations showed a 43 hp loading within the allowable time-on period in place of selecting the next larger size to be safe.

A summary of the answers to this third question shows that 20 of the 29 replies could get along on only three ratings, the ½ hour, the 1 hour, the continuous and the curves.

The fourth question asked was: "Do you believe 75 degrees C temperature rise is the desirable maximum? Do you feel that improved insulation, etc. will permit raising this?" The answers were as follows:

1. Twenty answers favored the 75 degree limit.
2. Seven thought the limit could be increased.
3. Two did not answer the question, and felt the decision should be left with the manufacturer.

The second part of the question brought the following replies:

1. Seven said improved insulation would permit raising the temperature.
2. Twenty said it would not, and six of these said the lubrication and bearings would govern the increase rather than insulation.

TABLE IV

COMPARISON OF SPEEDS USING RATINGS OF PRESENT STANDARD MOTORS WITH SAME LOADING APPLIED TO PROPOSED MOTORS

Frame No.	1-Hour rating				½-Hour rating			
	Hp	Rpm	Proposed motor rpm	Per cent increase	Hp	Rpm	Proposed motor rpm	Per cent increase
2	5	900	1010	12	6½	750	880	17
3	7½	800	840	5	10	660	725	9
4	10	725	850	12	13½	610	660	8
6	15	650	760	17	19	560	640	14
8	25	575	600	4	33	520	540	4
10	35	525	570	8	45	480	510	11
12	50	500	600	20	65	440	510	16
14	75	475	540	13	100	420	460	10
16	100	460	500	9	135	410	440	7
18	150	450			200	385		

3. Two said it was a decision for the manufacturer.

Practically all replies which favored an increase in temperature rise contained reservations which indicated it was more of a possibility than a probability.

The fifth question was: "Assuming that increased horsepower is put into the present frames, should speeds be held at present standards for the same horsepower or for the same frame size? The answers to this question were as follows:

1. Nineteen said that speeds should be held at present standards for the same horsepower.
2. Eight said that speeds should be held for the same frame size.
3. Two answers were not clear.

This question was apparently interpreted in several ways so that the answers may not be a positive indication of what is desired. "Assuming that increased horsepower is put into the present frames, should speeds be held at present standards for the same horsepower" could mean for example that a present Frame 10 motor, with a one hour rating of 35 hp and speed of 525 rpm would be replaced by a motor having a speed of 500 rpm at a one hour rating of 50 hp (this being the present rating and speed of the Frame 12 motor). The speed at 35 hp would be 570 rpm assuming similar speed curves to those for present motors. The statement could also mean that a present Frame 10 motor, with a speed of 525 rpm at 35 hp, would be replaced by a motor whose speed at 35 hp was 525 rpm. In this case the speed at the one hour rating of 50 hp would be appreciably less than 525 rpm and in all probability less than 500 rpm. The portion of the question, "Assuming that increased horsepower is put into the present frame, should the speeds be held at present standards . . . for the same frame size," was interpreted to mean that a present Frame 10 motor with a speed of 525 rpm at its one hour rating of 35 hp, was replaced by a motor with a speed of 525 rpm at a one hour rating of 50 hp. The question was also understood to mean that a present Frame 10 motor with a speed of 525 rpm at the one hour rating of 35 hp would be replaced by a one hour 50 hp rated motor with a speed of 500 rpm (the present Frame 12 rating and speed). This last interpretation gives the same effective change in motor size and rating as the first one mentioned in this paragraph but from a different mode of reasoning.

Table IV has been compiled to show two particular speed relationships for the case where a standard motor is replaced by a new motor in the same frame size whose new one hour hp and speed rating is the same as the one hour rated hp and speed of the next larger present frame size.

This tabulation shows that for the same one-half and one hour rated loads, the speed increases will vary from 4 to 20 per cent. The increased speed, however, will increase the motor load so that the actual net increase is less than that shown. The published curves for the frame sizes do not have the same shape which accounts for these variations. The largest variations will probably occur at the light loads and excess speed conditions may occur when substitutions are made at the lower proposed ratings.

The foregoing is an attempt to present the problem of proposed changes to our mill motor standards and to set forth the opinions of a cross-section of our membership on several items in this problem. No decisions have been made on any of these items, and it is hoped that the discussions will be of help to the committee which will consider all suggestions before making their recommendations for any changes and additions to the present standards.

DISCUSSION

PRESENTED BY

JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

T. G. DAWSON, Shop Supervisor, Bethlehem Steel Company, Bethlehem, Pennsylvania

V. E. SCHLOSSBERG, Superintendent, Electric and Power Departments, Inland Steel Company, East Chicago, Indiana

WALTER H. BURR, Electrical Superintendent, Lukens Steel Company, Coatesville, Pennsylvania

G. E. STOLTZ, Manager, Metal Working Section, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

L. A. UMANSKY, Assistant Manager, Industrial Engineering Divisions, General Electric Company, Schenectady, New York

C. B. HATHAWAY, Manager, D-C Motor Division, Westinghouse Electric Corporation, Buffalo, New York

C. W. LANGE, Engineer, D-C Armored Motor Engineering Division, General Electric Company, Erie, Pennsylvania

R. W. GRAHAM, Superintendent, Electrical Department, Bethlehem Steel Company, Lackawanna, New York

James Farrington: Mr. Cramer and his committee have prepared a very interesting comparison between the present mill type motors and the proposed new type. When a new type of motor is proposed or brought out, we naturally think of the new spares we will be required to purchase, thereby increasing our inventory. Conversely we cannot stand still and retard the development of new ideas and materials. In general, the question must be answered by the individual as it applies to his plant.

In many cases, the new line would relieve an overloaded motor application at less cost than changing the base plate to accommodate the next larger frame. We believe, however, that the speeds should be kept as near as possible to the present motor frames. This would especially be desirable in replacing the present motors with one of a higher rating at approximately the same speed, thereby using the additional horsepower to relieve the overloaded condition at the same speed

or cycle. Greater efficiency is always desirable, especially if it is at less cost.

We believe 75 C temperature is the desirable maximum, until materials have been developed and tested at a higher temperature. This high temperature may be objectionable in a hot location such as soaking pit covers and dampers.

New applications using the proposed new design should provide liners or distant plates to allow the use of the present motor, otherwise we would be confined to the new design. Other manufacturers will be compelled to build a competitive line which will mean another style to carry.

We firmly believe that the physical dimensions of mill motors as listed in AISE standard should be retained.

We believe two ratings per frame would be sufficient, namely, the ½ hour rating and the continuous.

Should other manufacturers design a motor that would have a larger rating per frame than the proposed motor, it would mean another style to carry in stock. What we would all like to see would be a motor designed by all manufacturers that would have the same physical dimensions, and have the armature field coils, and brush holders interchangeable.

I would like to ask the following questions:

1. Would the temperature of shunt wound motors stay under 75 C?
2. Could the high temperature materials be readily supplied, and at a reasonable price?
3. Can the proposed motor ratings be materially increased by forced ventilation?
4. Should the proposed motor be accepted, how long would it be until it is in production?

L. R. Milburn: We in Detroit have been testing one of the new mill motors on a pit crane. To date, we have made certain tests and collected certain data, which are not ready for publication. This information was collected for the benefit of the General Electric Company.

I believe we are fairly well sold on this type of motor; in fact, we have bought several for a screw-down installation where we needed more horsepower than we could get in the old 400 series frames due to limitations of the clearances required by the roll changing rig. By using the new 600 Series, we were able to get a 75 horsepower motor on these mill screw-downs. I believe, like Mr. Farrington, that we should hold the speeds of these motors to the present mill speeds; in other words, a 412 motor or an MCSA-12 motor should carry the same speed, whether it is the new series or the old series.

However, that is not a great problem because if you intend to install a larger motor on a certain drive, the chances are you will have to change the drive as well because of the increased load. The motor is not always the bottleneck in changing drives due to excessive overload.

With the increased ratings, you gentlemen say, "Well, I have to purchase additional spares." When we went to the old mill type motor we didn't worry too much about the spares. You came out with the standardized motor, and you bought the spares for it for your new plants. Then you came out with the short frame size and you bought spares for it.

I am wondering how big a problem the handling of spares is in your mills. We have in our plant one armature, and a set of field coils for each frame size, and in some cases we will carry a complete motor where there is a multiplicity of that frame. The problem of spares does not seem to be too bad when you consider that you are getting something additional for your money. In order to standardize we must have more than one make of motor.

T. G. Dawson: In April of this year I attended a small meeting in Philadelphia at which time we were given some preliminary information on the new 600 series motor. I also attended the Erie meeting in May and feel that General Electric Company is to be commended for their efforts in developing the proposed new line. However, I would like to mention a few facts which should be given careful study by the committee.

I believe we all agree that our present standardized motors have very little reserve capacity. It seems to be general practice at present to figure horsepower required and then play safe by choosing the next larger frame for the application.

In Table I, Mr. Cramer has pointed out the wide variation in percentage increase in ratings, particularly in the No. 6 frame in which the increase is 73.8 per cent for the ½ hr rating. Since this frame is still in the development stage, no test data is available but the following mechanical facts are of interest:

1. Shaft diameter at the pinion of the 406 and 606 Frame is 2½ in. Shaft diameter at the pinion on 408 frame is 3 in. This represents a reduction in cross section of 30 per cent with the proposed increase of 73.8 per cent in rating.
2. Under No. 3 of the proposed changes, an increase in bearing sizes is suggested. This is true as to frame size but not horsepower.

Frame	Bearing Size	Bearing Diameter	Bearing Width
406	313	2.56	2.19
606	315	2.95	1.46
408	316	3.15	2.56

For the 606 Frame the shaft diameter at the bearing is less than the present 408 Frame and the bearing width is decreased 1.1 in. or approximately 40 per cent. To compensate for this, the distance from center line of pinion to center line of bearing has been decreased and a solid bearing of greater load capacity will be used.

The above should be given careful study to prevent shaft breakage due to concentration of load over a smaller shaft area.

In order to meet the increase in shaft size at the bearing, the new design calls for use of a fillet at the inside end of the taper. In the past I believe most of us have found fillets a definite weak spot.

Mr. Cramer has also pointed out the increased speed for given horsepower ratings. Taking the No. 612, for example, if we use this motor to replace a No. 412 on a crane bridge, the load increases from 65 hp to 75.4 hp. and since many of our gear reductions are now 5 to 1 or 6 to 1, we may not be able to make gear changes to compensate for the above increase.

I also note that the greatest percentage increase in speeds occurs in the small frame sizes. Since these sizes are in general used on crane trolley drives, the

replacement of any overloaded 400 Series motor with a 600 Series will require gear changes before any improvement is made.

On trolleys equipped with roller bearings, it is now frequently necessary to use a drag brake in order to control trolley movement and the use of higher speed motors will aggrevate this condition.

The suggestion has been made that we consider some changes in ratings. Since the above figures indicate that existing ratings with reserve capacity will be hard to meet, I believe some changes in ratings should be considered particularly in the No. 6 and No. 12 frames.

Our present standards were drawn up twenty years ago with minor additions in 1940. With increased cost of labor and materials we must now recognize new designs and decreased weights with corresponding decreased costs as a necessity and I believe a conservative rerating of the new motor will answer our problem.

V. E. Schlossberg: We at Inland Steel like the proposed line. One of the big advantages of the proposed line is that a great many people apply the motors based on the largest motor they can fit in a given space. For this method of application, we in the operating department will obtain a motor with more horsepower, thereby resulting in lower motor maintenance cost.

A number of our boys have looked over the proposed 600 Series. There is one point which has caused considerable comment, and that is the shaft diameter of the pinion fit. It is the consensus of opinion in our plant that the top of the taper of the pinion fit should be the same diameter as is used for the bearing size, in other words, keep the pinion fit to the greatest diameter.

This will call for a larger pinion fit than that on the proposed 612. I don't recall if the pinion fit is as large as the 414 but we would not let the size of the pinion fit of the 414 influence us.

We would make the shaft at the pinion fit the same as is proposed for the shaft at the bearing fit, though it might mean the use of a pinion with a few more teeth, if a pinion is now used with the smallest possible number of teeth. We believe that with the use of the same speed as for the larger frame size, we could add another tooth to the pinion and end up with the correct speed. I might state for the benefit of those present that in our plant we have applied the next larger size motor where we had a large number of that size, using the same gearing as was used on the previous motor with no bad results regarding speed.

Walter H. Burr: Mr. Cramer's questionnaire and the results which he has tabulated have brought out opinions which should be helpful to the standardization committees.

Last Saturday evening I had an opportunity for the first time to examine the proceedings of the first, second and third meetings of the AISEE. I learned that Crocker-Wheeler claim the distinction of being the first to equip rolling mill tables with electric motors. They realized at that time, 1892, that the railway type motor was not adapted to that service, and brought out in 1893 a motor looking somewhat like a railway motor but having different characteristics and adapted to 220 volts. They claim the distinction of having coined the term "mill type motor" and that this motor was the first mill type motor ever built.

In the fall of 1906, Westinghouse Electric Corporation had on their test floor a complete line of motors designed to meet the need of the steel industry. These motors were designated as type MT motor and it was these motors which the Westinghouse Electric Corporation invited 28 men from the electrical departments of the various steel companies to inspect on April 26 and 27, 1907. On the 26th, Mr. James Farrington suggested the organization of this Association, and on the morning of the 27th temporary officers were elected.

In October of that same year, on the ninth and tenth, the first annual meeting was held at which time a paper was delivered on standardization. In the discussion which followed, some quite heated arguments took place on standardization. However, it was not until ten years later that W. T. Snyder delivered the paper which resulted eight years later in the standardization of mill motors.

When we consider standardization of mill motors, there are three parties involved: the motor builder, the builder of steel mill equipment, and the steel industry. Standardization was adopted for economic reasons and all of the above mentioned parties are involved. The motor builder should be able to effect certain savings, the mill equipment builders should be able to reduce the cost of design, first costs and installation of this equipment. These savings should be shared by the steel industry. But these savings must be compared with the cost of spares which must be carried by the steel industry to insure maximum production with minimum delays. When these savings to the steel industry equal the cost of spares that must be carried, then and then only, will it be economically sound for representatives of the steel industry to sanction the adoption of new mill motor standards.

When comparing these savings, consideration must be given to the fact that in a short time after new standards are adopted, replacements for spares for the thousands of motors now in use will be increased very materially.

With reference to the proposal which has been submitted to the Association for consideration, I feel that if the motor builders see fit to put on the market a line of motors to which they assign the present AISE frame sizes and dimensions with horsepower and speed ratings of the next larger frame sizes, it will make possible the installation of a certain number of motors on application now under-motored and where larger frame sizes cannot be used because of physical limitations. But if this new line of motors is standardized when new mill equipment is installed, it will be necessary to purchase new spares adding to the large number which even now must be carried in spares.

The establishment of a smaller frame size would be very necessary to complete this line of motors and bearings, and shaft dimensions would have to be changed to enable this design to meet the service imposed on it. The addition of a larger frame size in a 200 hp rating would possibly be advisable.

It took 18 years to get the first standards approved, and for 14 years no change in these standards was made. It has been only six years since recommendation to change these standards was approved by this Association.

The replies to the questionnaire, with the exception of the first question, were so varied that I believe the

standardization committee should give very careful consideration to this proposal and not adopt any new standards until they can be economically justified by the steel industry.

G. E. Stoltz: Mr. Cramer has indicated in his Figure 1 that today the same material will produce 40 horsepower that was used in 1905 to produce 5 horsepower. He has also pretty clearly shown that it is time to make another advance in our mill motor design. The last step on his curve started in about 1929, and ends in 1940. The previous step is some thirty per cent below the 1929-1940 level. I have checked the time at which we introduced our present mill type motor, and I think it was around 1928, so it corresponds very closely to the last step in his curve.

The change that we will make will be substantially the same as shown on Mr. Cramer's curve so that we seem to be working along the natural trend of using materials more advantageously. I think the manufacturers are in a position to make this change, and if the steel industry feels it is justified, I see no reason why the change should not be made. It is our recommendation that it be made.

There are several things that can be done. One is to extend our standardization on details, and another is to omit certain methods of rating. I see no particular reason in retaining the one-quarter hour rating, as I believe it is seldom used. We should go as high as a one hour horsepower rating of 200 on the 18 frame. There is some question in my mind as to whether we should standardize the five horsepower rating on a new No. 1 frame. One or two speakers have suggested that we increase the number of ratings. I personally prefer simplification as the present ratings cover the field very well and it reduces the spares needed by the users.

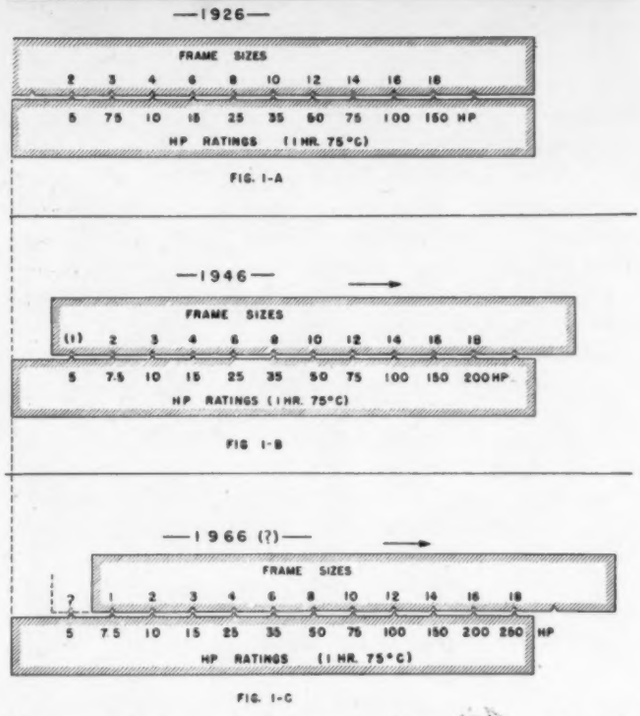
I think there is one thing that the steel manufacturers should consider as a problem for the electrical manufacturers, and that is whatever decision is made it should be unanimous. It will not be economical to have two lines of mill motors.

L. A. Umansky: A sensible standardization of motors is based on a blend of two conflicting ideas: On one hand there is the obvious desire to maintain intact something which is "good enough" and not to upset such features as interchangeability, spares, existing machine designs, etc.; on the other hand there is an equally strong desire to give the industry the benefit of continuous development of new materials and new ideas.

This apparent conflict between the two schools of thought can be more readily solved if we realize, as we should, that there are really two standards involved, and not one. Let me illustrate this point by the case of mill type motors.

When your Mill Motor Committee tackled this problem back in 1926 (and in subsequent years), it provided in effect two distinct kinds of standardization:

1. Ten steps of motor ratings, from 5 hp to 150 hp, 230 volt, were selected, each hp rating being associated with one, and only one, motor speed. This permitted the motor users and the machinery builders to guide their requirements into ten channels. The 20-year experience has shown that the choice made in 1926 was by and large satisfactory. The motor manufacturers could concentrate on this limited number of ratings, and have succeeded in maintaining a much lower price level than would be otherwise possible for the high grade type of motors demanded by the steel industry.
2. Ten sets of motor mounting dimensions, i.e. ten motor "frame sizes," were established. This fact enabled the users to interchange motor per motor of different makes, and permitted the mill and crane builders to standardize on their designs, which, of course, benefited the entire industry.



Changes in frame ratings may be likened to a slide rule in which the horsepower ratings are on one scale and the frame sizes are on the other scale.

These two kinds of standardization are graphically shown on Figure 1A, with the one-hour hp ratings marked on the lower part, and the frame sizes on the upper part of an imaginary slide rule. These two parts are biased by several evenly spaced dowels and grooves. Figure 1A shows the 1926 setting of the slide rule and ties together the motor ratings and frame sizes, as they existed for the last 20 years.

Now, the engineering progress is a continuous process. No sooner is any relation between the motor rating and physical dimensions established than the designer begins to think and devise means of putting more hp in a given frame. Obviously, if this is done a bit at a time, say by 5, 10 or 15 per cent increments, a frequently repeated change of standards would bring only disturbance and annoyance to all concerned. Instead of this we should allow the engineering progress to advance sufficiently to permit us to move our slide rule a whole notch, and not a fraction of it. Figure 1B shows what is being proposed now, in 1946. Please note that the two Association standards set in 1926, i.e. the rating standard and the dimensions or frame standard, are maintained; but the upper part of the slide rule is moved to the right by one notch.

If we put only one restriction on our designers, i.e. if we tell them to work hard, to invent and develop new

materials, new skills, etc., but that we will change the relationship between the ratings and dimensions only when we can jump one entire frame, then we will succeed in happily blending standardization and engineering progress. The movements of our slide rule will not be erratic, but will occur only every 15 or 20 years. Probably in 1966, steel will still be rolled and mill type motors will be still in demand; I may be excused for day-dreaming that by that time, or a little sooner, new inventions of which we have no inkling now will give us new magnetic and insulating materials, new steels for shafts, bearings and other mechanical parts, so that the slide rule could be moved again another notch; something which cannot, obviously, be done now.

Now, if we, on the other hand, would weld together the two halves of our slide rule at its 1926 setting and would refuse to consider any such changes as now proposed, then indeed we would interfere with engineering progress for the sake of temporary convenience, to the ultimate detriment of the industry.

Comparing again Figures 1A and 1B we observe that by moving the upper slide to the right one notch we create two additional possibilities:

In the first place, the Frame 18, becoming divorced from its 150 hp rating, is now available for the next larger rating, i.e. 200 hp. Since this frame has been previously standardized as to mounting dimensions, it is logical to extend the range of standardized ratings to 200 hp, which is called for, more and more frequently, in many mill applications.

Secondly, at the other end of the range, the 5 hp rating is left without a frame. Depending on the demand for this rating, a new smaller frame, No. 1, can be developed; or, if the demand is relatively low, the "1926" frame No. 2, with a 5 hp rating, can be temporarily used, side by side with the new 1946 frame No. 2, which has the same mounting dimensions, but a 7.5 hp rating.

Under the proposed plan the definite hp rating rather than the definite frame size should be tied to a certain rated speed. After all, if you build or install a machine requiring, say, a 50 hp, 1-hour rated motor with a rated speed of 550 rpm, and if you have previously employed the frame 12 and designed your gearing accordingly, you will probably take advantage of the new design and will get the 50 hp motor in the new frame 10. In other words, a certain job usually calls for a certain horsepower, and not a certain frame. Ordinarily the smaller new frame will always fit in where the larger old frame did.

I do not believe that in more than one case out of ten it will be essential to duplicate the frame number without needing more capacity. But, even in such case, the actual machine speed will not be much changed. Don't forget that the majority of mill auxiliary drives now employ compound wound motors and for a given load torque the speed will be practically the same whether, for instance, the old size 12, 50 hp motor, or the new size 12, 75 hp motor is applied. With series and heavily compounded motors, any discussion of speeds should not be carried to the nth point, since the estimated load is a variable, and a guessed, quantity anyway. Shunt motors are usually employed in Ward Leonard circuits, and speed can be readily taken care of in several ways.

I believe that we have altogether too many ways of naming the same motor. Exactly the same machine may be now called 90 hp (15 min), 65 hp (30 min), 50 hp (1-hour), 22.5 hp (5 hours), to cite just a few of several possible ratings or names. Of course, as motor manufacturers, we really should not care whether you maintain the present multiplicity of names or not; in this case we are dealing not with things like frame sizes or maximum torques or speeds, but merely with words.

However, as engineers interested in the steel industry, we feel that the more names we have for the same machine, the more confusion we are apt to get all around, and the greater is the chance for a misapplication.

How do we select a motor for a given job? There are two principal methods, precedent and calculations. In the first case, in applying a motor to, say, a screwdown, or a table, or what have you, you may reason something like this: On a similar mill elsewhere, for the same kind of work, we have used a 75 hp motor; hence let us call for 75 hp on the new job as well; or, if the 75 hp motor was laboring too hard, we may go to the 100 hp size. Now, in this line of reasoning, you want to be certain that you are thinking and talking of the same hp, not 30 minute rating at one time and 60 minute or 5-hour rating at another time. With only one "name" given to a given motor the chance for making a mistake is minimized.

Suppose, on the other hand, that you are analytically inclined and go through a set of duty cycle calculations to select the proper motor. In this case neither one of the existing ratings has any practical or physical value. The only way to get correct results is to estimate the load and the "percent time-on" of the duty cycle and then check the corresponding performance curves prepared by the motor manufacturers. Once you go through this work, you do not need any of the so-called ratings, from 15 min to 5 hours. You merely need a "name," and only one name, to be given to each motor. It does not make much difference which of the several names is chosen, but if I had my way I would select the so-called mill type or 60 minute rating, not because it is, in itself, any more correct than the others, but simply because it is most widely used in the industry. Such a single name, plus the performance curves, is all that is needed for applying and operating the motor drives.

I believe that the present standard of temperature rise, namely 75 C by thermometer, or its equivalent by resistance, should be maintained. It should be clearly understood that the new proposed ratings of standard frame sizes are based on this temperature rise. It is true that there are new insulating materials available, which taken by themselves would permit safe operation at a higher temperature. However, we should keep in mind that we are discussing d-c motors; that commutating limit determines the maximum motor torque; and that the best kind of insulation and high temperature do not in themselves improve the commutation. Since the high value of torque is the essence of mill type motors, we should resist any temptation to raise the permissible temperature limit.

C. B. Hathaway: Since a question has been raised regarding the activity on the part of Westinghouse in the new motor program, I wish to make it clear to you at this time that we at Westinghouse are very much behind this program. It is our opinion that during the

twenty years since the present line of mill motors has been designed, there has been sufficient advance in the art of design and in the new materials available which would amply justify a consideration of a replacement design.

The present proposal of dropping the ratings one frame size may seem radical. I should like to point out that there was a considerable reduction in the physical size of the motor when the present line was designed twenty years ago. In the case of our MC motors, the one hour ratings were on a different standard than with the old motors. For example, the 40 MC had a rating of 20 hp, and the 50 MC, a rating of 30 hp. There were no corresponding ratings in the new line-up. These ratings became 25 and 35 hp respectively. In addition to the increase in hp the frames were actually smaller with the new rating than with the old lower rating. I make this point merely to show that there was a marked decrease in the frame size when the present line was designed.

A question has been raised about the size of shaft extension on the proposed new line of motors. We have made careful checks using the larger bearing with a 20 degree stub tooth; and it is our conclusion that the shafts on the proposed designs are adequate for the new higher ratings.

There is a definite advantage in keeping this same size shaft extension on the proposed line, as on the old frames, which would permit the use of old pinions and gears. Nevertheless, if it is the studied opinion of the Association that they would not be satisfied with the proposed size shaft extension, then we, as manufacturers, are willing to meet the desires of the Association.

The new motor will have an adequate margin of safety for their ratings. It is our opinion that the new motors will have performance equal to, or greater than, the old motors of the same ratings; and that there is sufficient advantage in the reduction in size and the improvement in performance to justify the supersedure of the present standards.

C. W. Lange: The new line of mill type motors now being developed by the General Electric Company have the same physical or mounting dimensions and the same basic hp and speed ratings as the present AISE standard motors but with such standard ratings obtained in the next size smaller AISE frames.

As a matter of historical interest, I might mention that the basic one hour enclosed mill ratings for 230 volt series wound motors, as listed in Mr. Cramer's paper, were officially approved by the Association of Iron and Steel Engineers and the three manufacturers of the AISE standardized mill motors on April 16, 1926, and are the present standard ratings.

The half-hour or crane ratings for 230 volt series wound motors as listed in Mr. Cramer's paper were, however, subsequently changed to the following ratings:

Frame	½ Hr crane rating	
	Hp	Rpm
A	10	650
B	13	610
C	19	560
D	33	500
E	45	460
F	65	440
G	100	420

In 1940 ratings for compound, shunt, and adjustable speed 230 volt motors were added to the standards, as well as ratings for series, compound, and shunt wound, 550 volt motors and ratings for semi-enclosed, self-ventilated protected motors, both 230 and 550 volts. In addition, values for maximum starting and running torque for all ratings were included in the standards.

Mr. Cramer states that the original standardized motors were the so-called long motors which had sleeve bearings, and that during the next ten years anti-friction bearings were developed for use with these motors. I might point out that, actually, the first standardized motors manufactured by the General Electric Company were anti-friction, roller, bearing motors. The length over the bearing housings was, however, made long enough to permit the use of sleeve bearings. This is the reason why the original AISE standard motors were "long" motors, whereas the present day AISE standard motors are "short" motors because the demand for sleeve bearing motors was found to be negligible at first and then non-existent.

Figure 1 in Mr. Cramer's paper, showing the increase in hp rating for one size of a line of general purpose motors during the years 1905-1940, might be misinterpreted since the hp rating only of a motor without reference to its speed is an indefinite kind of rating. It would, therefore, provide a clearer picture of what has been done if values for "hp per 100 rpm" were used instead of hp values only. Of course, if the hp values shown are based on the same speed in each case, this comment is unnecessary.

The tabulation (Table A) for nine representative sizes of General Electric mill type motors of different vintages, in groups of three motors, of fairly comparable size and weight, illustrates what has been done and is being done in connection with direct current mill type motors.

Relative to item 3 of the proposal submitted by the General Electric Company, to which Mr. Cramer refers, it may be well to point out that this proposal contemplates no change in the AISE standard shaft extensions for any AISE frame size, but does propose increasing the bearing sizes and the shaft diameters through the bearings and through the armature spider or quill in order to maintain shaft safety factors equivalent to those for the present motors of the same ratings. In this connection, it will be of interest to note that the AISE standards require a shaft factor of safety not less than 12 for the ½ hour crane ratings based on the use of ordinary shaft steel having a tensile strength of 60,000 psi. This value of 12 is exceeded for all sizes of old and new motors.

The General Electric Company's proposal that the 20 degree stub tooth form for gearing be standardized for the new mill type motors is based on the following considerations:

If the load of a present day motor were imposed on the gearing for the next size smaller motor, for example, if AISE frame 12 loads were imposed on the gearing for the AISE frame 10, it is apparent that the tooth stresses would be undesirably increased and the life of gears and pinions reduced unless a stronger tooth form were used. Analysis shows that the 20 degree stub tooth form already used to some extent in the steel mill industry meets this requirement very satisfactorily

TABLE A

Date	Frame size	Weight	Dimensions*		One hour enclosed rating			Hp/100 Rpm per 1000 lb
			D in.	LM in.	Hp	Rpm	Hp/100 Rpm	
Before 1926	MD-104A	1550	10½	41¾	20	725	2.76	1.78
After 1926	MD-408-AE	1470	11¼	39	25	575	4.35	2.96
After 1946	MD-608-AE	1575	11¼	35	35	525	6.67	4.24
Before 1926	MD-105-A	2150	12	44	40	550	7.28	3.38
After 1926	MD-412-AE	2500	13⅜	47	50	500	10.0	4.00
After 1946	MD-612-AE	2900	13⅜	41	75	475	15.8	5.46
Before 1926	MD-108-A	6250	17¾	64	100	500	20.0	3.2
After 1926	MD-416-AE2	4850	16	52	100	460	21.8	4.5
After 1946	MD-616-AE	5350	16	52	150	450	33.3	6.23

*D — Height from bottom of feet to centerline of armature.
LM — Length over bearings or bearing housings.

and limits the tooth stresses to values equivalent to those when the old 14½ degree Brown and Sharpe tooth form was used with the present smaller ratings and loads.

Table I in Mr. Cramer's paper shows the per cent increase in hp ratings for the proposed new motors for both the 1 hour and ½ hour series wound 230 volt enclosed ratings. It might be well to point out that on a torque basis or a "hp per 100 rpm" basis the values for per cent increase in rating are considerably higher than shown.

For example, in the case of AISE frame 6 the per cent increase in the one hour torque rating is 89 per cent as compared to 66⅔ per cent increase in the one hour hp rating, and the per cent increase in the ½ hour torque rating is 95 per cent as compared to 73.8 per cent increase in the ½ hour hp rating.

Table II in Mr. Cramer's paper shows that the speed of a series wound motor of the next size larger rating is somewhat higher at a given hp load than the speed of the smaller capacity motor at the same hp load.

Mr. Cramer points out, however, that in actual operation the higher speed of the larger capacity motor automatically increases the hp load so that the actual differences in speed will be less than those shown in Mr. Cramer's table. This is a very important consideration and can be interpreted as meaning specifically that in actual operation it is the speeds at the same torque

TABLE B

COMPARISON OF SPEEDS FOR GIVEN LOADS ON THE EXISTING AND PROPOSED FRAME SIZES

Frame	2	3	4	6	8	10	12	14	16	18	420
Rated hp	5	7½	10	15	25	35	50	75	100	150	200
Rated torque	29	49	72	121	228	350	525	830	1140	1750	2560
Torque					Speed in rpm						
15	1170	1190	1270								
29	900	940	1000	1130							
49	720	800	840	910	1050						
60	640	720	780	845	960						
72		660	725	795	880	960					
121		520	600	650	720	790	820				
160			530	580	655	700	730				
190				540	620	660	690	860			
228				510	575	615	645	775			
290					540	560	600	710	710		
350					505	525	560	660	665		
410					480	500	535	615	620		
470						480	515	585	590	720	
525						460	500	560	570	680	
625						425	470	530	540	640	675
725						400	450	500	515	605	635
830							430	475	495	575	600
930							410	460	480	550	570
1030							400	445	465	535	550
1140								435	460	520	530
1500								395	415	480	485
1750									395	450	460
2000									375	435	445
2560									345	405	410
3000										390	390
3500										375	370
4000										360	355
5000											325

values which should be compared instead of the speeds at the same hp values.

To illustrate how these differences in speed shrink when torque values are considered the tabulation (Table B), which is similar to Mr. Cramer's Table II except that rated torques and various torque values are used instead of hp values, has been prepared.

This tabulation indicates that at rated torque values the difference in speed for series wound motors of any two consecutive ratings in the series is on the order of 2 per cent in one case, 4 per cent in two cases, 5 per cent in one case, 7 per cent in two cases, 10 per cent in one case, 11 per cent in one case, 12 per cent in one case, and 13 per cent in one case.

It may be well to point out that in the case of compound wound motors, these differences in speed at the same torque values become quite small, and that in the case of shunt wound motors, the differences in speed are actually reversed and the speeds are always less for the larger capacity motors.

Mr. Cramer refers to the higher speeds at light loads when larger capacity motors are substituted bodily for the present smaller capacity motors. In this connection I am glad to be able to say that the new motors will permit of maximum safe speeds on the order of 10 per cent higher than the maximum safe speeds of the present motors of the same hp and speed rating.

Cases where a mechanically interchangeable new motor, of the same dimensions as but with a greater rating than an existing motor, is substituted because of severe overloading may not be very numerous, but when such substitutions are desirable, it would appear that in most cases they might be made with little or even no change in gearing or control.

Table III in Mr. Cramer's paper indicates that the 25 hp, 35 hp, 50 hp, and 75 hp sizes have been in the greatest demand, and that the demand for the 5 hp size has been greater than the demand for the 7½ hp and 10 hp sizes. Our experience confirms these conclusions in a general way except that the demand for the 15 hp and 100 hp sizes has been about 50 per cent greater than shown. Our records for the years 1940 through 1945 show that the sales of the AISE frame 2 constitutes 5.5 per cent of the total as compared to 5.3 per cent for frame 3 and 6.3 per cent for frame 4. This indicates that the demand for frame 2 is comparable to the demand for frames 3 and 4, which is one reason for our proposal that a new AISE frame 1 be added to the standards for the 5 hp rating.

One item in Mr. Cramer's paper gives a value of 150 cfm air for each kw loss to obtain a continuous force ventilated rating equal to the one hour enclosed rating. This value is a conservative one as we have found that a value of around 100 cfm to 125 cfm air per kw loss is adequate for such ratings. It may be well, however, to point out that if ratings are increased much above this normal rating, the air requirements per kw loss increase very rapidly.

Relative to the various alternating systems of speed ratings discussed in Mr. Cramer's paper, it is my considered opinion that the best method by far is the one proposed, namely, to maintain the AISE standard speed rating for the corresponding AISE standard hp ratings regardless of any change in frames.

R. W. Graham: Mr. Cramer has ably presented a summary of the progress made in mill type motors over the last forty years. When a representative group of electrical men witnessed the description and tests of the newly designed proposed mill motors at Erie last May, it was apparent that the new motor was well received.

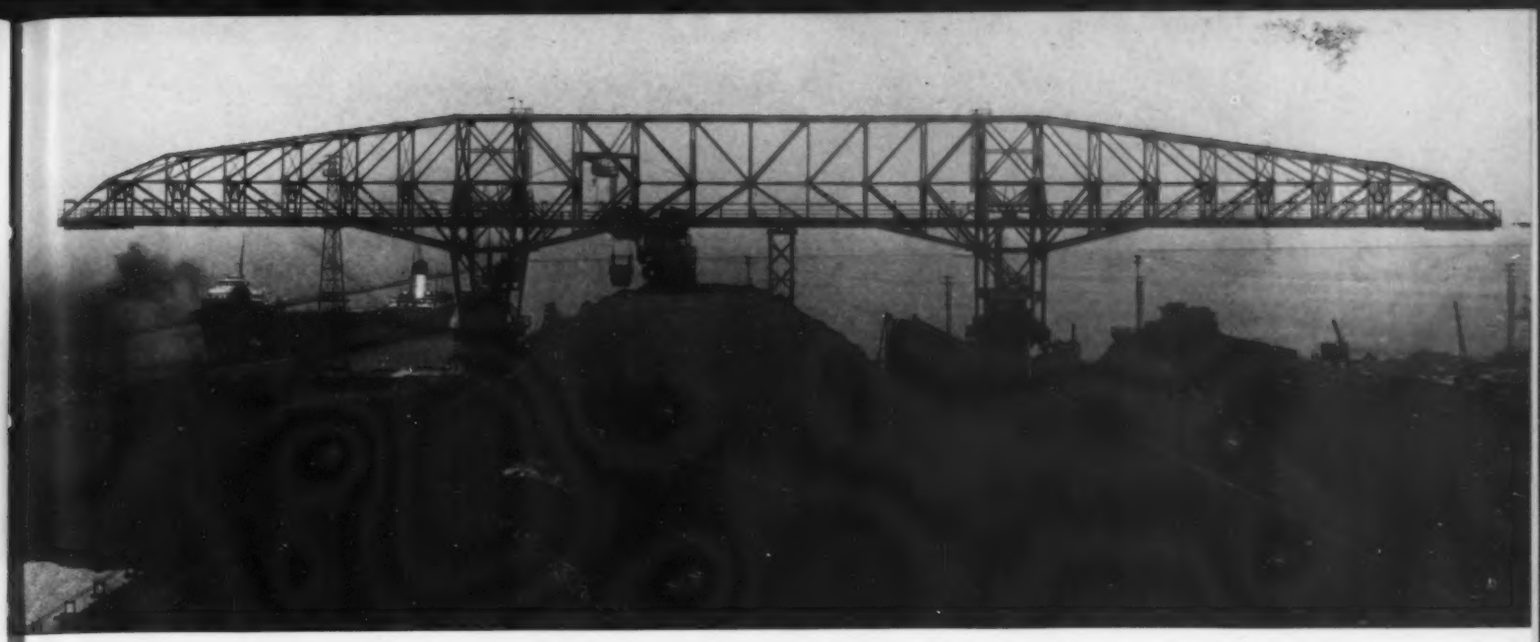
Most recent improvements have been the solid roller bearings, with bearings closer coupled, higher maximum safe speeds, and improved insulation. The 1926 standardization lost some of its effectiveness as it had two standards, one the long motor and another the short or shovel motor. In a majority of all our steel mill applications the WR^2 inertia effect of motor armature and brake wheel during acceleration and deceleration is quite pronounced. I would like to have seen longer and small diameter armatures to accomplish a still lower WR^2 than will even be accomplished by raising the hp rating into the next smaller sized frame.

If the compilation is correct that only 2 per cent of the entire output is back axle motors, apparently the crane manufacturers must have applied the greater portion of them. We do not use the roller bearing back axle, but have been using nominal diameter back axle sleeve bearings equipped for grease lubrication. This permits nominal commercial stock sized shafts for use in back axle shaft section of bridge line shafts. I would like to hear an expression from other operating men along this line.

The 20 degree involute tooth is proposed on the new line. We are (with exception of cranes) getting away from direct gear drives and applying the motor through a flexible coupling to the driven unit. As the new motor may have larger shafts over the 1926 model frames, the pinions will not be interchangeable anyway, and I believe this is the proper time to ask crane and machine builders to change motor gear reductions from the 14½ to 20 degree involute tooth, which now is the machinery and diesel drive manufacturers' prevalent tooth profile.

One feature which should be well received is the capability of putting a higher rating motor on a present heavy overloaded job, where space requirements would not permit the larger frame. As many of these present overloaded jobs are a question of reversing, accelerating, and decelerating loads, the final speed is of little importance, and with the new motor frame and a change of resistor layout, we can get practically duplicate operation of previous operation without burnouts of the motor.

While we have been guided by the ½-hour and 1-hour ratings when applying the mill type motor, these ratings seldom represent the duty cycle of a reversing, plugging mill table drive, a crane bridge motion making long runs on a runway or short runs when used as a piling crane. The final logical application is determined more by what previous similar jobs have been successful or those that have given excessive maintenance.



HANDLING MATERIALS FOR STEELMAKING

. . . . no other industry has so many and so varied material handling problems as the steel industry . . . .

By CHARLES M. PARKER

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NEW YORK, NEW YORK

▲ THE steel industry of the United States handles more materials per ton of finished product, and in a greater variety of ways, than any other large-scale manufacturing industry in the world. It has been estimated that for every ton of finished steel shipped, 68 tons of raw materials, steel-in-process, by-products and waste products are handled. Internal freight, or total principal materials handled during 1945 add up to the astronomical figure of 3,913,000,000 net tons.

Presented before Conference on Materials Handling, Cleveland, Ohio, January 15, 1947

In walking through a steel mill some of the "materials" are not obvious to the uninitiated, such as the air blown into blast furnaces and bessemer converters, and the water which cools blast furnace tuyeres and bosher and rolling mill rolls; but they do have weight and bulk and they must be moved efficiently and economically.

After extraction from its resting place in the earth, iron ore may be handled no less than five times before it emerges from blast furnaces as liquid metal. And there is little inefficiency, if any, in the handling proces-

Lift trucks are extensively used in handling coils of strip.

ses. The greater part of the ore must be mined and transported during the "open weather" season of early April to early November. Let us put a tracer on a particle of ore from the Mesabi range to the freight car taking the finished steel in which its iron is contained out of a steel mill.

Operations start with stripping overburden from the deeper-lying ore. In 1945, more than 113,000,000 tons of overburden and other debris were moved with heavy-duty power shovels. Depending upon conditions at the ore face, the shovels may deposit their burden on a specially designed freight car or motor truck, or on a conveyor belt. The ore may be routed through a washer, thence to storage bins from which freight cars are loaded to take the ore to the classification yards and storage bins on the docks at upper lake ports. From those storage bins, huge ore carriers are loaded by gravity and the long trip to lower lake ports is begun. At Cleveland, the carriers are unloaded by Hulett unloaders and the ore may go to railroad cars for immediate transportation to steelmaking centers further south or onto stock piles for future rehandling. Let us assume that we have taken our ore directly from carrier to freight car for use in a Cleveland steel plant. The freight car dumps its load on the highline from which the blast furnaces are burdened.

Burdening the furnaces requires special materials handling machinery. It has been estimated that those little skip-hoists made more than 58,000,000 trips and travelled more than 1,800,000 miles during 1945 in burdening the furnaces of the American steel industry with 175,000,000 tons of ore, cinder, scrap, limestone and coke. And in order to bring that quantity of materials to the furnaces it was necessary to handle a total of 1,078,000,000 tons, exclusive of the 247,000,000 tons of air which were heated and blown into the furnaces and the 1,698,000,000 tons of water which coursed through their vital parts.

When the 55,000,000 tons of molten iron and ferro-alloys produced in 1945 left the furnaces, 27,500,000 tons of slag and 330,000,000 tons of gases left with it. The liquid iron was taken from the furnaces in specially designed ladle cars or "bottle-cars" and shipped to mixers or direct to steelmaking furnaces. The slag was moved in cinder ladles for processing into cement or rock wool, or for disposal.-The gases were bled from the furnaces through special equipment for processing for further usefulness.

At the steelmaking furnaces, specially designed massive machinery charges them with their burdens of hot metal, scrap, limestone, ore and ferro-alloys while other specially designed materials handling equipment bring to the furnaces the 44,000,000 tons of scrap, 5,900,000 tons of fluxes and 7,600,000 tons of fuel needed to process those materials into molten steel.

Nearly 80,000,000 tons of molten steel was tapped into ladles during 1945 together with 16,000,000 tons of slag. The liquid steel was teemed from ladles into ingot molds which were stripped from the ingots when they had solidified enough to be placed in soaking pits. Each operation along the way was performed by materials handling equipment designed especially to move the hot metal speedily, economically and safely.

And up to now, although it has not been previously mentioned, more than 3,760,000 tons of refractory materials have been employed to confine the heat of the many processes.

In solid form, the metal is transported and manipulated entirely by machinery and from ore to finished product there is hardly an operation in steel production in which "lift-and-carry" labor plays an important part.

As semifinished steel materials move toward finishing operations, and as finished steel moves toward freight cars, all sorts of specialized and standard cranes, conveyors, tractors, lift trucks and similar equipment are employed. Hot rolled bands are taken to the cold mill by specially designed conveyors, or by ram tractors; plates are run out on castor beds for cooling, inspection and identification; tin plate is taken from shears or inspection benches by lift trucks; and, sheet steel is skillfully loaded into closed cars by a special type of truck known as a "wiggle-tail."

Although steel is very rugged stuff when it is finally in place in a finished device, some kinds are rather tender until they have been through final fabrication and heat treatment operations. Steel can be severely damaged, or even rendered useless for the purpose for which it was manufactured, by poor handling.

Autobody sheets must be handled in such a fashion as to maintain maximum cleanliness and flatness; cold finished bars must be protected against severe blows and rubbing or the value of the injured piece will be impaired or even ruined. Tin plate and highly polished stainless steel sheets must be handled to avoid rubbing and damage to edges or corners; pipe and tubing must not be bent or "sprung" and threads must be protected from dirt as well as from mechanical damage. Products like music wire and razor blade stock must be protected from even light blows and any suggestion of grit or dirt.

These are but a few of the special problems which are met daily in the steel industry and solved successfully by the intelligent use of properly designed and properly operated materials handling equipment. But those problems could not be met as successfully as they have been without some measure of standard equipment, standard procedures and standard methods of packaging and handling finished products for shipment. In that field, the steel industry has an excellent record of achievement. The future holds promise of even greater achievement with willing shoulders at the wheel.

Analyis of Centralized Lubricating Systems

. . . . describing nine systems of centralized lubrication in present use . . . .

By JAMES P. GRAVENSTRETER

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Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946

▲ OVER the period of the past several years many of us have heard papers about centralized lubricating systems, which papers have normally dealt with one particular manufacturer or system. It is the purpose of this paper to aid operators and engineers in selecting a centralized lubricating system for a particular job by discussing the design, operation and other physical features of nine systems used in the steel industry today.

The paper is divided into four parts, namely:

1. A discussion of the component parts of every centralized lubricating system, with a short review of the development of dispensing valves.
2. A definition of four types of centralized systems which are used in the industry, and a discussion of their design and operation.
3. A tabulation of the physical features of each of nine systems of various types in use today.
4. General remarks about the choice and operation of centralized systems.

Centralized lubricating systems as covered in this paper are confined primarily to the application of oils or greases to bearings or points of friction making use of an application device known as a dispensing valve, which delivers a measured quantity of lubricant periodically upon pressure impulse from a central pump. As such, then the paper does not include mechanical oilers such as are used in connection with the lubrication of steam engine cylinders and many other types of mechanical equipment, or with oil circulating systems used for supplying lubricant to oil film bearings such as are used on roll necks.

The function of a centralized system may be somewhat different, depending upon the age and type of equipment it is to serve, and should be chosen accordingly. Older equipment usually contains many sleeve type bearings which, due to large bearing clearances and lack of effective bearing sealing, normally require a large amount of lubricant to maintain them in service. On the other hand, anti-friction bearings have enjoyed a much wider use in recent years and they require a relatively small quantity of lubricant to maintain the lubricating film, while the major portion of the lubricant serves only to seal the bearings against outside contamination. In general they require much less lubricant than a sleeve type bearing of the same capacity.

In the production of new machinery today, many manufacturers include some type of centralized lubricating system at the factory. The manufacturer frequently sets up the lubricant quantity, type, and frequency of application requirements for each point, and it is, therefore, a simple matter to install a system to supply the machine lubricant needs. This type of planning usually results in the installation of a system well suited to his equipment so that both the machine and system operating results are satisfactory.

The more difficult side of the centralized lubricating system installation problem is in equipping, in the field, old or used machinery whose bearings may be worn to various degrees. In many of these cases we operators and engineers do much of the layout and design work in the field and may over-install system capacity to be assured of satisfactory operating results. We may also find, after the system is installed, that it does not perform as expected, since we cannot supply certain bearings with sufficient lubricant or may not be able to pump the proper lubricant, etc., all because we have not selected the correct system for the job. This paper

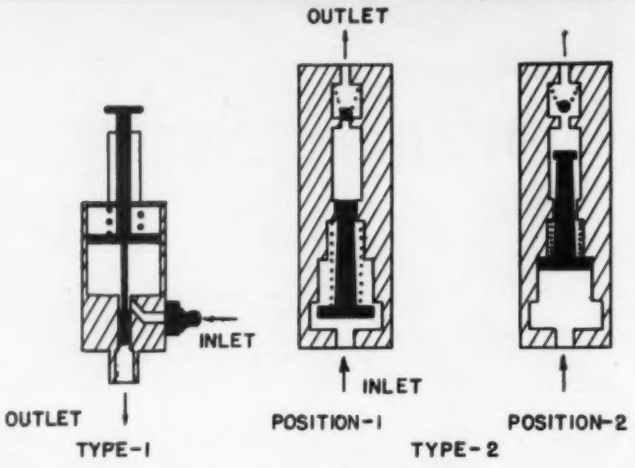


Figure 1 — These early type dispensing valves measured out a pre-determined amount of lubricant.

may be of some value in preventing some of that type of installations.

All centralized lubricating systems have four things in common, regardless of the type of system or its manufacturer:

1. Grease pump to supply lubricant at high pressure to the system.
2. Main line piping to supply lubricant from the pump to the dispensing valves.
3. Discharge line piping, hose, etc., for supplying lubricant from the dispensing valves to the points of lubrication.
4. A device for discharging the measured quantity of lubricant known as a dispensing valve.

Pumps and pumping units for operating centralized systems are designed and built to fulfill the lubricant pumping requirements of each particular system and as such they vary widely in design, pumping pressures, discharge capacities, etc. Four general types of lubricant pumps are used with the systems described later in the paper and these are 1. hand guns; 2. permanently mounted manually operated reservoir type pumps; 3. electric or air motor power operated barrel pumps; 4. electric motor operated reservoir type pumps.

Power pumps are used when the system becomes too large to be readily served by a hand pump, or where the pumping cycles are so frequent as to require too much of an operator's time to adequately lubricate the equipment. Hand operated systems require all manual manipulation, while power operated systems employ power pumping with hand or automatic manipulation.

Both hand and power pumps built to operate one system have been used, with slight changes, to operate other systems for which they were not designed and have given satisfactory results, so that it is possible, in case of necessity, to operate a system satisfactorily with parts of another system.

Sizes and types of main and discharge line piping are governed usually by the type of system and the lubricant that is used, and each manufacturer usually has his own specifications covering size and strength of the piping to be used with his equipment. In general, however, it is usually good economy to use extra heavy galvanized pipe and fittings on main line installations, as although the physical strength of the pipe may not be needed to withstand the line pressures, the galvanized coating helps preserve the piping, and the extra wall thickness gives it more resistance to external damage.

For satisfactory operation over a long period of time with low line maintenance cost, it is necessary to securely anchor the piping and tubing and protect it against routine operating and maintenance damage. Main line failure on any system results in waste of lubricant and often in bearing failure, neither of which is the fault of the system itself, but are many times the result of a faulty installation.

It is desirable to fill both the main and discharge line piping with lubricant as they are assembled, as considerable time may thus be saved in placing the system in operation. Some operators do, however, prefer to complete the piping of the system first, and then pump a light oil through the system to coat the walls of the piping to minimize line resistance when the regular lubricant is pumped into the system.

The fourth and most important part of any centralized lubricating system is the dispensing valve which delivers the measured quantity of lubricant to the bearing. This device is essentially the heart of the lubricating system, and the other parts of the system are built around it.

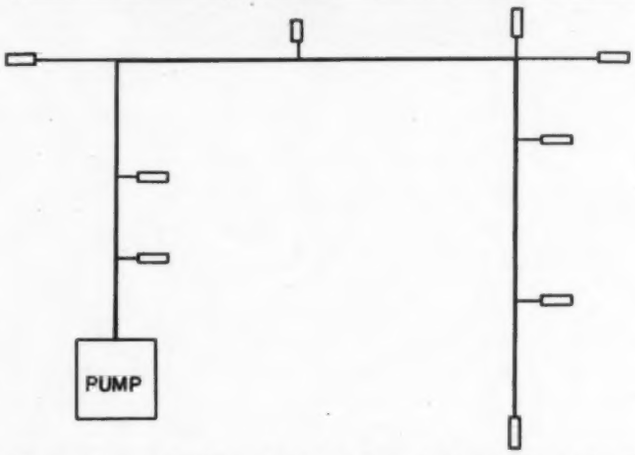


Figure 2 — A single main line of supply is used in a single line terminating system.

Over a period of years the average oiler in the mill has tried, perhaps like all of us, to make his own job as easy as possible. Therefore, he probably created the first semblance of our present day centralized system when he prevailed upon the pipefitter to run lines from each of the bearings on a piece of equipment to one central point on the machine. This made it much easier for him to lubricate the machine, with a higher degree of safety, without having to shut it down. With this improvement, however, the oiler did miss some of the points while he was overlubricating others, and the net result generally was that the machine became messy with excess lubricant and still had bearing failures. It was apparent that where this move had been an improvement, there was need for a device that would supply a predetermined quantity of lubricant to the bearings.

One of the successful devices designed to supply a predetermined quantity of lubricant was a spring loaded grease cup shown in Figure 1. This was a modification of the regular grease cup and was filled by an external hand gun through a hydraulic fitting and used

a spring loaded piston to discharge lubricant in a continuous flow to the bearing. The flow was accomplished through the use of a pin which was fastened to the main piston, the bottom end of which was provided with a large thread that fit loosely into a small passage in the bottom of the main chamber. The lubricant was forced out of the chamber through the threads on the bottom of the pin. As the spring expanded, grease was forced out of the chamber, the piston descent causing the pin also to pass out of the passage, maintaining a somewhat near constant flow of lubricant from the cup because of the shorter path of lubricant travel. This device, although an improvement over earlier methods of lubricant delivery, was ineffective because it did not have sufficient pressure to overcome line and lubricant resistance in many applications, but with all their apparent disadvantages as metering devices a number of them are still in use today. Since they had to be supplied lubricant individually they really only increased the time interval between bearing refills.

The problem, therefore, was to have sufficient pressure available to push a definite quantity of any lubricant that a grease gun would handle out into a bearing from a central pump through a piping system and a

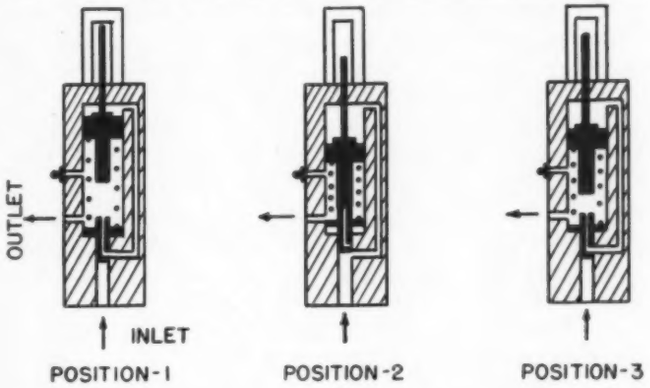


Figure 3 — Valve operation of Supplier A's single line terminating system valve.

metering device without having to worry about ambient temperatures. In an early form of this type of valve, lubricant supplied at high pressure from a main supply line entered the bottom of the valve where it started to build up pressure against the main piston spring by flowing around the main piston to the middle of the valve thus starting to raise its small stem end out of its passage, Position 1 of Figure 1. The incoming lubricant then sealed the large end of the main piston in the chamber after the stem had moved a small amount and forced it to discharge a volume of lubricant ahead of it to the outlet, Position 2. Upon release of the main line pressure, the check valve would seat and the spring would return the main piston gradually to its former position. The return action was possible because of the rather loose fit of the large end of the piston in the main bore so lubricant could pass slowly around the outside of the piston as the spring forced it back.

This valve, although it was supplied lubricant from a main line, was still not satisfactory, as it could not effectively dispense all of the lubricants that are normally required in heavy industry, so, although a step in the right direction, still did not fully meet all the requirements of a centralized lubricating system dispensing valve.

The main discharge piston and valve idea of this 1926 dispensing valve finally was incorporated into a fully hydraulic valve that was the forerunner of all the hydraulic dispensing valves used today.

In the discussion of the various systems that follow later in the papers, there are four features that each valve has in common.

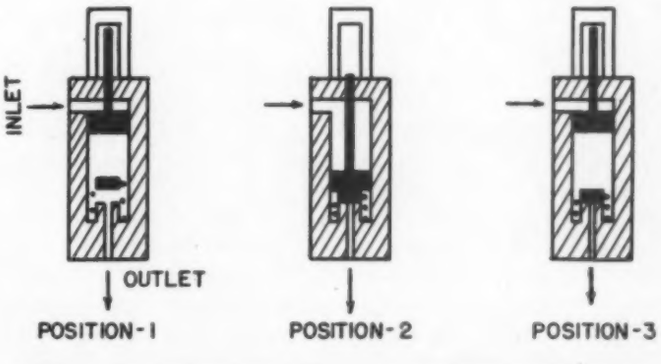
1. For a valve to dispense lubricant an unbalance of total force on the opposite sides of the main piston is required, that is, the force applied on one side of the main piston by incoming lubricant must be greater than the resistance offered by the bearing and discharge line piping on the other side.
2. Some method of providing opposing forces for each side of the discharging piston must be employed so that the piston may be forced in each direction.
3. Each of the dispensing valves used in centralized systems employs a main piston and some type of internal sliding or ball check valve or valves which direct the flow from the supply line to the main piston, and may check the return flow of the lubricant from the bearing and position the valve to discharge lubricant on the next pumping cycle.
4. Each valve uses incoming lubricant pressure in every case to force the lubricant ready for discharge out of the valve to the bearing.

In general there are four types of centralized lubricating systems in use today. There are 1. single line terminating; 2. two line terminating; 3. two line progressive or circuit; 4. single line progressive.

Single line terminating systems use a single main line to supply lubricant to each of the dispensing valves terminating the line at the last valve, see Figure 2. In operation the lubricant enters the line under pressure from the pump and the dispensing valve with the least resistance operates first, and then the one with the next lowest resistance, etc., operates until all the valves have operated. With this system, therefore, there is no definite pattern of valve operation, as each one will operate when it has received sufficient pressure from the main line to overcome whatever resistance there may be in the valve and the bearing it supplies.

Valves for dispensing lubricant in this system are provided with external indicator stems so that the

Figure 4 — Valve operation of Supplier B's single line terminating system valve.



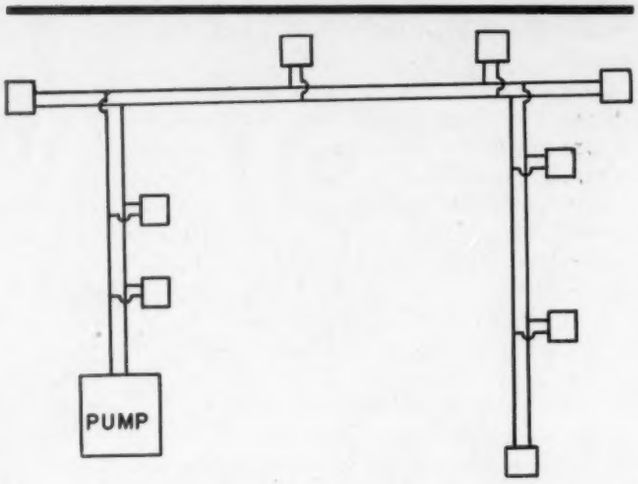


Figure 5 — The two line terminating system allows full hydraulic operation of the valves.

piston movement may be observed, and a screw limiting the piston stroke, thereby adjusting the quantity of lubricant discharged by the valve. Normal pressures to operate the system vary from 1000 to 5000 psi, and may be supplied either by a hand or a barrel pump.

In Figure 3, high pressure lubricant from the main line enters supplier A's single line terminating valve at the bottom under the spring loaded sliding valve, Position 1. Under increasing lubricant pressure from the main line the sliding valve is forced up so that a side port is uncovered, permitting lubricant to pass into the main chamber on top of the spring loaded main piston. Incoming lubricant then forces the piston down, discharging the lubricant under it to the outlet. When the main piston contacts the top of the slide valve it has traveled the full length of its stroke, Position 2. Upon release of the pressure in the main line the slide valve again seats, opening the lubricant inlet passage in the valve body to the bottom of the piston chamber through the slide valve. The potential energy of the piston spring forces the lubricant from the top of the piston chamber through the passage in the side of the valve body into the bottom of the piston chamber. When the piston reaches the top of the chamber again, the valve action has been completed and it is in position to repeat the operation upon the next pumping cycle. A hydraulic fitting is provided in the side of the main chamber whereby lubricant from a hand gun may be pumped directly to the bearing if necessary, and also the outlets of several valves may be connected in series under this arrangement.

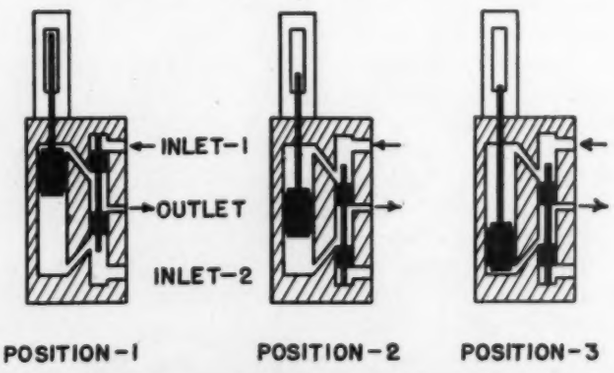
In Figure 4, high pressure lubricant from the main line enters supplier B's single line terminating valve at the top of the main piston, Position 1, and forces it downward until it reaches the bottom of the chamber. In this operation, the lubricant below the piston that remained from the previous cycle is discharged through the outlet port in the bottom of the valve. The piston in its downward travel, however, finally closes off the outlet port by seating the small check valve in the bottom, Position 2. Continued application of lubricant pressure from the main line forces lubricant around the main piston, which has a rather loose fit in its cylinder, causing the piston to rise again to its normal position. The piston moves upward as the area of the bottom of the main piston is larger than the area of the top of the piston because of the indicator stem, and with the same pressure being applied to both sides of the piston there is a larger total force on the bottom which forces it up again. After the indicator stem has reappeared, showing that the piston has returned to its normal top position, Postion 3, the main line pressure is released and the small check valve at the outlet which has remained closed because of the pressure in the chamber is returned by the spring to its original position, and the valve is then ready for the next cycle.

An essential difference between these two systems is that one valve operates when the pressure on the main line is released, while the other operates under continued application of pressure. Each system may be operated by a hand or air motor operated power barrel pump which may be manually or automatically controlled.

The second type of centralized lubricating system, the two line terminating system, is so named because it requires two lines from the main pump to supply lubricant to each dispensing valve line terminating at the last valve, see Figure 5. The valves for this system are hydraulic and use incoming lubricant pressure to discharge lubricant and to position the slide valves which control the operation of the main pistons. These valves operate entirely by incoming lubricant pressure, and each is provided with an external indicator stem, so that the movement of the piston may be observed, and a screw for limiting the piston stroke, thereby adjusting the quantity of lubricant discharge by the valve. Each of the valves functions in turn according to the amount of resistance that is offered by the valve and the discharge line, so that the one with the least resistance will operate first and then the one with the next lowest resistance, etc., until all the valves have operated. Operating pressures of two line terminating systems are between 1000 and 1500 psi.

The operation of supplier C's two line terminating system dispensing valve, shown in Figure 6, is as follows. Lubricant enters the valve from main line one at inlet one, Position 1, and forces the slide valve into the extreme bottom position uncovering the top cross port to the main chamber and the bottom port from the main chamber to the single outlet line. Lubricant flowing through the top cross port enters the main chamber forcing the piston down, discharging the lubricant under the piston that remained from the previous cycle,

Figure 6 — Valve operation of Supplier C's valve.



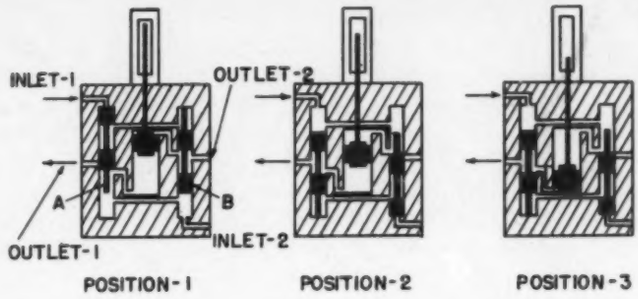


Figure 7 — Valve operation of Supplier D's valve.

to the outlet line. This valve dispenses lubricant from each side of the main piston to the same outlet line, and it is necessary to pump one main line only to deliver lubricant to each point in the system. On the next cycle the lubricant is pumped into main line two and inlet two, causing the valve to reverse its action and discharge lubricant again on the upward stroke.

In Figure 7, lubricant from main line one enters supplier D's two line terminating system valve at inlet one, Position 1, and forces slide valve A down, uncovering the top cross port to slide valve B. Slide valve B is then forced down opening the cross port to the top of the main chamber. Continued supply of high pressure lubricant, Position 2, forces the piston down, discharging lubricant from the bottom of the chamber to outlet one. When the piston reaches the bottom of its stroke, Position 3, the valve has completed its operation on that pumping cycle, one-half of the bearings having received lubricant. To lubricate the other half of the bearings in the system it is necessary to repeat the above pumping cycle on line two. Supplier D's valve is adjustable, as are all two line terminating system valves, but the lubricant that is discharged from opposite sides of the main piston supplies two different outlets; therefore, the adjusted quantity discharged to one outlet must be the same as that discharged to the other one. A single outlet is obtained by cross drilling the two outlet ports into one internally, or by making an external cross connection.

Lubricant from the main line one enters inlet one, Position 1, of supplier E's two line terminating system valve, shown in Figure 8, at the top of the main chamber, forcing the slide valve down until the undercut port in the side near the top of the chamber and outlet port one in the bottom are uncovered. Lubricant then flows around the slide valve through the undercut port and forces the piston, which is free to move on the slide valve separator stem, down, discharging lubricant from the bottom of the main chamber through outlet one. When the piston has completed its downward travel by contacting the lower part of the slide valve, all of the lubricant has been discharged to outlet one.

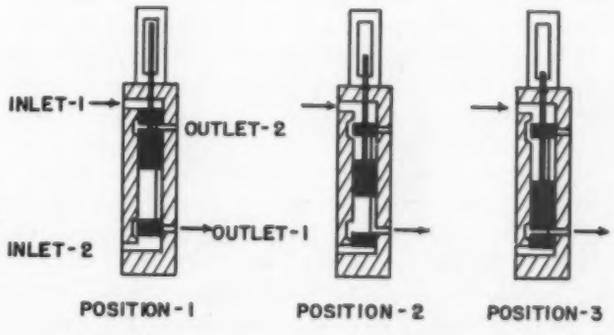
Only one half of the bearings in the system have received lubricant on this pumping cycle so that the system must be pumped again, repeating the above procedure, on main line two. This valve must supply the same adjusted quantity of lubricant to each of the outlets, as the volume discharged from either side of the piston must be the same. For a single outlet with this valve it is necessary to cross connect the two outlets externally.

Each of these three two line systems require delivery of lubricant pressure in one main line and then in the other. Two line systems are operated by hand, electric and air operated barrel, and electric motor operated reservoir pumps. Manual two line terminating systems use pump discharge pressure and indicator stem position to show that the pumping cycle is completed on one line, and then reverse the system to pump in the other main line by means of a manual valve. Reversal for the two line automatic systems may be accomplished in any one of three ways: 1. return line hydraulic pressure from some point in the main line; 2. end of the main line pressure by means of an electric switch; and 3. discharge pressure at the pump, depending upon the system supplier.

Two line progressive or circuit systems, illustrated in Figure 9, are so named because of the sequence of dispensing valve operation. Lubricant is supplied to the hydraulic dispensing valve nearest to the pump first, and it must operate this valve before it passes on to the next valve in the system, etc. The system is progressive in action and the manifolds are piped together in a loop which starts and ends at the pump. Lubricant in passing through each one of the progressive valves in this type of system is discharged to only one half of the outlets so that when it has completed the circuit in one direction, the flow is reversed and the lubricant is pumped back through the system in the opposite direction. In the reverse direction it returns the valves to their original position, dispensing lubricant from the other half of the outlets in the system. Due to the progressive nature of the system operation, each valve must deliver its full volume of lubricant in its turn or the system becomes blocked and will not operate. The discharge volume of each valve must be the same each time it operates so that the system may function properly; therefore, it is not possible to vary the quantity of lubricant discharged from any one of the valves. Indicator stems are not provided on the valves so that the fact that the system is operating and the indicator stem at the pump is working is the indication the operator has that all the valves are operating.

In Figure 10, lubricant enters supplier F's two line progressive valve from the main line at the top, Position 1, contacts and closes the ball check valve. Lubricant pressure then forces the slide valve downward,

Figure 8 — Valve operation of Supplier E's valve.



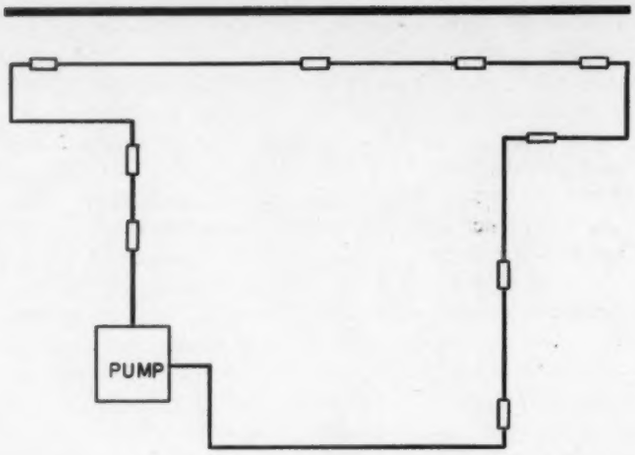


Figure 9 — In the two line progressive system, it is not possible to vary the amount of lubricant discharged from any one valve.

uncovering the undercut port in the top side of the main chamber and at the same time uncovers the port to outlet one at the bottom of the chamber. Lubricant continues to flow into the valve forcing the piston, which is free to move on the slide valve separator stem, down, discharging lubricant through outlet one Position 2. When the piston has completed its travel by contacting the bottom of the slide valve, a small hole in the hollow slide valve separator shaft is uncovered, Position 3, permitting the lubricant to pass into the shaft and out through the bottom of the valve unseating the bottom ball check and on to the next valve. Only one of the two outlets on each valve receives lubricant in the above operation, so that after the lubricant has operated each of the valves progressively in one direction it must then be pumped back through the valves as described above to furnish lubricant to the other half of the points in the system. For a single outlet point the two outlets from one valve are connected together externally.

To operate supplier G's two line progressive valve, Figure 11, lubricant enters the top of the valve from the main line, Position 1, closing a small floating valve, causing the lubricant to flow to each side of the valve where it contacts a slide valve. Continued supply of lubricant forces the slide valves down, uncovering an inlet port to the top and an outlet port from the bottom of the main chamber, Position 2. Lubricant pressure on top of the piston forces it down, discharging the lubricant under it to outlet one. After the piston has moved to its extreme bottom position a port in the side of the chamber is uncovered, permitting the lubricant to pass out of the chamber unseating the small floating check valve and out of the valve into the main line and on to the next valve, Position 3. Only half of the outlets have received lubricant so that the system must be pumped in the opposite direction to complete the lubrication of the other half of the points in the system and the lubricating cycle is then complete. To obtain a single outlet with this valve it must be cross drilled internally to connect both of the outlets to one point or it may be cross connected externally.

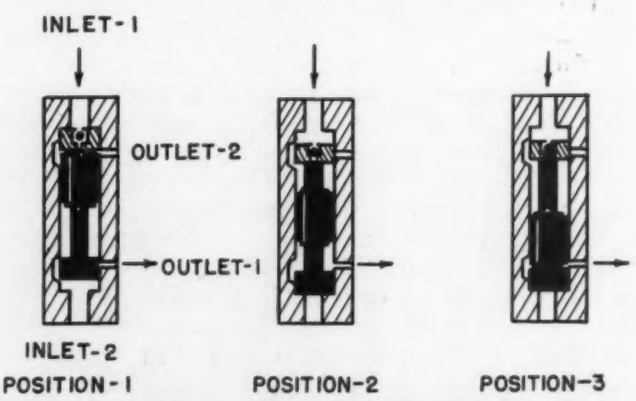
For hand operation each of these two systems employs a manual pump with an indicator and a reversing valve mounted on the side. Power systems may be operated with an air operated barrel pump or an electric motor operated reservoir pump, with manual or automatic reversal, depending upon the supplier. It is common practice with this type of system to use a distibution valve which may connect several different circuits with the main hand or power pump, and then pump each circuit as lubricant is required. The reservoir type pump uses the pressure of the lubricant after it has operated the valves in the system to operate an indicator stem at the pump which electrically reverses the flow of lubricant in the system.

The fourth type of lubricating system, shown in Figure 12, is the single line progressive system which is also known as a multiple line system. This system uses several progressive type valves to discharge lubricant through long outlet lines from a compact manifolded valve unit, rather than from numerous individual valves along a long main line. Essentially there are two types of this system; the one employs a hydraulic valve while the other uses springs, and side porting in the main chamber, in the valve operation. The latter system, although progressive in operation, is normally supplied for operation by means of a hand gun.

These systems, like two line progressive systems, must operate the valve nearest the pump first, and then the next nearest, etc., until all of the valves have operated. There is only one main line and each bearing in the system receives lubricant on each pumping cycle.

In Figure 13, lubricant enters supplier H's hydraulic dispensing valve at inlet one, Position 1, and passes through the center of dispensing valve one to the right end of valve two, forcing it to the left, discharging the lubricant remaining from the previous operation through outlet one. In Position 2, with valve two in its extreme left position, lubricant from the main line then flows through its center section and into the right end chamber of piston one, forcing it to the extreme left position discharging the lubricant remaining from the previous cycle to outlet two. In Position 3, with both of the pistons in their extreme left positions, lubricant again enters the center section of number one valve and the cycle is repeated in the opposite direction, discharging lubricant from outlets three and four. This operation is one that will repeat itself in a progressive manner as long as pressure is maintained in the main line.

Figure 10 — Supplier F's two line progressive system valve.

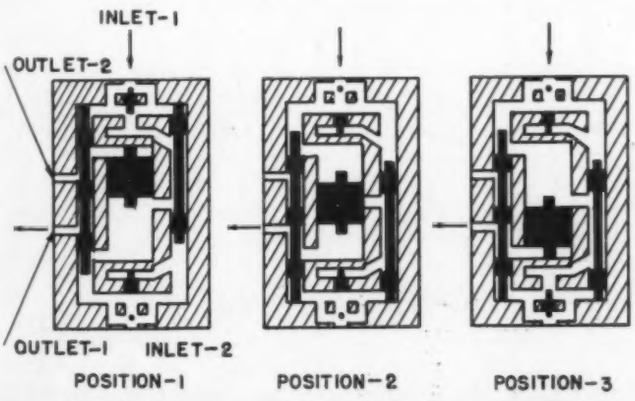


When these valves are incorporated in a large system, one of them will be supplied lubricant from the main line and then each outlet line will be used to serve another manifolded group of these valves. It may be well to note that each valve must operate and discharge its volume of lubricant before the next valve may receive lubricant from the main line for its operation. The speed of operation of this valve and the quantity of lubricant it will dispense in a period of time are dependent upon the grease supply pressure; in other words, more pressure, faster action, and more grease. This system may approximate continuous application of grease as the valves are small and thus discharge a small quantity of lubricant with each operation but they may be operated continuously.

This system operates at a variable pressure, and in practice a line from one of the dispensing valves is brought back to an indicator on the pump, which will indicate how much lubricant has been dispensed. Each of the valves dispenses a fixed charge of lubricant with each operation so that it would take a certain number of operations of the valves to fill up the indicator reservoir. After a definite quantity of lubricant has been dispensed by the system, the pumping may be stopped. This system may be operated by a hand pump or by a power driven reservoir pump either manually or automatically controlled.

In Figure 14, supplier I uses a spring operated valve in his single line progressive system. Lubricant is supplied by a hand gun through a hydraulic fitting to the bottom of valve one where it builds up sufficient pressure against the small needle valve on the bottom of piston one to force it off its seat. Piston one then travels upward discharging the volume of lubricant over it through a ball check valve into outlet one. When piston one completes its travel, it uncovers a port leading to the bottom of chamber two, and its piston in turn is forced to discharge its measured quantity of lubricant as did piston one. As its stroke is completed the piston uncovers a port leading to the next chamber, etc., each one in turn discharging its quantity of lubricant until the last one is reached. As the last piston completes its stroke, incoming lubricant passes through a port in the side of the chamber to an indicator stem. This indicates that all of the valves have discharged their measured amount of lubricant and that the pumping cycle is complete. The operator ceases pumping

Figure 11 — Supplier G's two line progressive system valve.



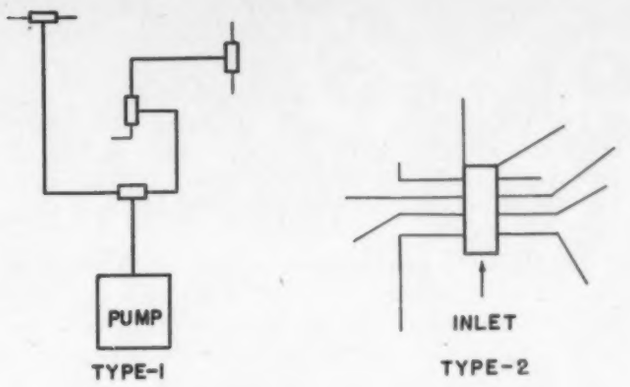


Figure 12 — Single line progressive system.

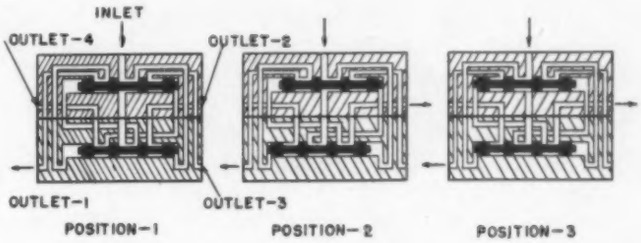


Figure 13 — Supplier H's single line progressive system valve.

and pushes the indicator stem back down, forcing a small amount of lubricant around the last piston through a small side port to the last outlet. After this is done, the valves gradually return to their normal position by forcing the lubricant from the bottom to the top of each piston through a milled slot in the side of each chamber. When each main piston spring has returned the valve to the normal position the system is ready for the next cycle.

In the discussion of each of the various systems of the four basic types we have given consideration to each method of operation and the various individual features which are available with a particular system, and it might be well to summarize some of these points.

1. A single line terminating system is not fully hydraulic because of the springs used in the dispensing valves, but the frequency of the pumping cycle and the discharge volume of each individual valve may be varied according to operational requirements through the use of the external indicator stem and adjustment screw.
2. A two-line system is fully hydraulic, because it uses lubricant supply pressure to operate the valves, and the pumping cycle and the discharge volume of a dispensing valve may be varied according to operating requirements through the use of the external indicator stem and adjustment screw.
3. A two-line progressive system operates each fully hydraulic dispensing valve progressively, and only the pumping cycle may be varied as their basic design requires that a definite volume be discharged from each valve on each pumping cycle, hence no valve adjustment nor external indicator stem is provided.

4. One single line progressive system has a fully hydraulic valve that operates progressively and the pumping cycle may be varied according to operating requirements, but the valves are not provided with indicator stems or individual adjustments.

The second type of single line progressive system does not use fully hydraulic valves but, like all progressive systems, the pumping cycle may be varied, but the valves are not provided with indicator stems and are not adjustable.

Table I of the paper is devoted to a tabulation of the various physical features of each of the nine systems on the market today. This is intended to show a comparison of some of the important details that are normally considered when selecting a system. The tabulation is so assembled that the systems of one type are listed so that one may compare them together as well as with the other types.

In the ultimate selection of a centralized lubricating system the operator or engineer should ask himself the following questions, and his answers will more or less determine for him what system he may choose for a particular job.

1. What type of lubricant am I going to use in the system?
2. What points of lubrication shall I include in this system and how far are they apart?
3. How much lubricant does each point in the system require normally, and how often does it need to be replenished?
4. Based on the extremes of temperature and the type of lubricant to be pumped, do I need a fully hydraulic valve?
5. If a fully hydraulic valve is required, should it be a progressive valve?

After he has answered these five questions he will have determined for himself what type of system he may require. He should then consult with the suppliers of that type of equipment and work out the details of each supplier's system and then choose the one system that will lend itself best to his particular application. In many cases, the system selection, however, may not be able to be reduced to such simple levels, as he may have other considerations and because of existing conditions may not be able to buy what he considers the proper equipment for a job. It would be well, however, in selecting a system to use these questions as a general guide in making his selection.

A problem common to all of us is how to make our systems function well the year round. One of the first answers would be to change lubricants winter and summer. Changing lubricants winter and summer, however, will not always solve all of our problems. Operators will agree that in many cases they find

TABLE I

Item		Supplier								
		A	B	C	D	E	F	G	H	I
1 Type of system	1. Single line terminal	x	x	...	...	...	...	...	...	...
	2. Two line terminal	...	...	x	x	x	...	...	...	...
	3. Two line progressive	...	...	...	...	...	x	x	...	...
	4. Single line progressive	...	...	...	...	...	...	...	x	x
2 Are valves fully hydraulic?		No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
3 Does a plugged valve or outlet line stop system?		No	No	No	No	No	Yes	Yes	Yes	Yes
4 Valve capacity per stroke — approximate ounces	Minimum	0	0	0.007	0	0	0.012	0.015	0.0028	0.0175
	Maximum	0.04	0.089	0.475	0.292	0.25	0.17	0.35	0.084	0.130
5 Valve sizes available		1	2	4	2	1	7	8	12	4
6 Outlets per valve		1	1	1	1 or 2	2	2	1 or 2	2	1
7 Valves per manifold		2, 3 4, 5	1	2, 3 or 4	2	3, 4 or 5	1	1	2 to 11	3 to 20
8 Outlets per manifold		2, 3 4, 5	1	2, 3 or 4	2, 3 or 4	6, 8 or 10	2	1 or 2	1 to 22	3 to 20
9 Type of pump used	1. Hand gun	...	...	...	...	...	...	...	...	x
	2. Hand pump	x	x	x	x	x	x	x	x	...
	3. Barrel pump	x	x	...	x	x	x	...	...	...
	4. Reservoir pump	...	...	x	x	...	...	x	x	...
10 Pump pressures — psi		1000-5000			1000-1500		500-800		300-500	
11 Indication of completed pumping cycle	1. Valve stem position	x	x	x	x	x	...	...	...	...
	2. Main line pressure	x	x	x	x	x	...	...	...	...
	3. Indicator at pump	...	...	...	...	...	x	x	x	...
	4. End of line indicator	...	...	...	...	...	...	...	...	x
12 Number of pumping cycles to lubricate system		1	1	1	2	2	2	2	1	1
13 Method of reversing system	1. None required	x	x	...	...	...	...	...	x	x
	2. Return line pressure	...	...	x	...	...	x	x	...	...
	3. End of line pressure	...	...	x	x	...	...	...	...	...
	4. Pump discharge pressure	...	...	x	x	x	...	...	...	...

themselves buying a particular lubricant because it may be readily dispensed through the particular system he operates rather than because it is the proper lubricant for the bearing. This is a wrong approach to the problem of correctly lubricating a bearing, because it is in effect catering to a system by reason of its pumping limitations rather than actually supplying the correct lubricant to the points to be lubricated. This type of problem has been with us as long as heavy bodied lubricants have been in use, and perhaps has been magnified in recent times with the increased use of centralized systems.

Another answer to the problem is to make use of external heat. This heat application may be in the form of lighted oil-soaked waste, a gas flame, a steam tracer, or perhaps, as is being used in some places, an electric heating cable. Steam tracers have been used for years, but they are not easily controlled and in many cases become so hot that the lubricant separates, giving rise to another problem. Warm pump rooms in this respect have an advantage in that they assure the operator that the lubricant may at least feed well into his pump. It will readily be seen that in cold weather the sensible heat in the lubricant itself actually would be dissipated a short distance from the pump house, when one considers that the lubricant in a one and one-fourth inch main line, supplying three hundred points of one tenth ounce capacity each, will only advance approximately four feet per cycle. Thus, the lubricant will advance only about eighty feet per hour on the basis of three minute operating cycle. Eighty feet of pipe in many mill systems will hardly get the lubricant to the first dispensing valve. Probably the idea with the most promise in this connection is the use of some sort of heating cable which can be fastened along the main line and then wrapped with insulation. These cables are of low wattage input, and with them it is possible to keep at least the entire length of the main lines at summer operating temperatures in zero weather. Although the original cost of the wire itself is relatively low, the extra cost of installing it and then insulating the main line may well approximate the cost of the installation of the lubricant line itself. Such a program does lend itself well, however, to new installation work where it may be engineered into the job along with the regular piping. This type of system may be provided with a thermostat control which will maintain the line at any predetermined temperature the year around.

A second problem is to find that long sought for all-purpose lubricant that is stable in hot and cold applications, in the presence of water, and can be dispensed effectively in a centralized system. There are some available, but for steel mill lubrication their cost is prohibitive so that we must resort to other practices for a solution of this problem. One solution is to get away from connecting all the bearings up on one big system and trying to use one lubricant for all applications. This has been the practice in many plants and is not too satisfactory, as the points receive sufficient lubricant but not of the proper kind.

The best and most economical practice seems to be to buy several small pumps and install small systems where a diversity of lubricants may be used, instead of one big system. The lubrication of a complete unit then does not depend upon the operation of a single pump and a single lubricant.

A third problem with centralized lubricating systems is one of servicing the system itself. Many operators feel that after they have invested in a "one shot" system, they then need only to keep the regular oiler around to supply the system with lubricant. This is not enough, as with the installation of a centralized system many of us are prone to neglect the routine inspections that were practiced before the system was installed. Most automatic systems employ some alarm device to warn the equipment operator when there is some abnormal condition in the main part of the system, but there is no alarm that shows when a discharge line is broken.

It behooves operators of centralized lubricating systems to assign competent people to tend their systems and make them completely responsible for their operation and maintenance. Good lubrication is as important as the machine itself, so that employees of the calibre of the machine operators should be used to maintain its lubricating systems.

In closing it might be well to summarize some of the conclusions drawn in the course of the paper.

1. Centralized systems are not new, but have been used and improved over a period of several years.

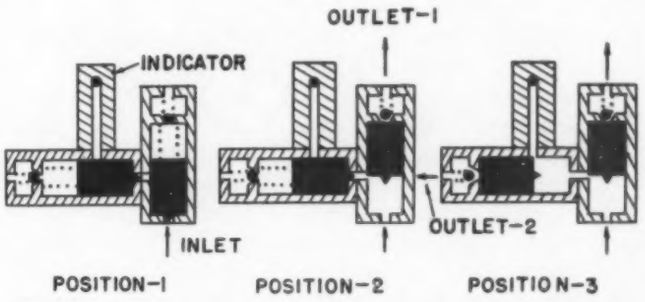


Figure 14 — Supplier I's single line progressive system valve.

2. Every system contains a pump, main and discharge line piping, and dispensing valves.
3. Single and two line terminating, and single and two line progressive systems are the four basic types of systems used in the industry today.
4. Terminating system valves have external indicator stems and are provided with screws for adjusting their discharge volume, while progressive valves operate in turn, one after another, each discharging a fixed volume of lubricant with each operation, and are not adjustable.
5. There are both fully and non-fully hydraulic valves available, depending upon the system chosen.
6. Condition and type of equipment, type of bearings, type of lubricant and frequency of application, and year around temperature extremes, are all factors to consider in selecting a lubricating system.
7. Some method of heating main lines is helpful in system operation in most industrial applications, especially when grease is the lubricant.
8. Better over-all operating results are generally ob-

(*Please turn to page 97*)

SUBMERGED COMBUSTION IN INDUSTRY

. . . . the use of submerged combustion can develop a saving of about 50 per cent of present pickling costs . . . . savings are attributed to better agitation, no dilution because there is no steam condensate, and much faster pickling . . . .

By WALTER GEORGE SEE

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HAMMOND, INDIANA

▲ UP to rather recently, the steel industries generally were inclined to think of submerged combustion as a "new development." Now, however, submerged combustion has made a place for itself by simply living up to its claims of producing more pickled steel at a lower cost. Its list of users has increased materially, not only in the steel industry where it is used to pickle wires, bars, plates, sheets, and pipes, but in the shipbuilding field where it is used to pickle plates, shapes, and fabricated parts; in the food industry where it is used to reduce the bacteriological content of certain solutions; in the chemical industry where it is used to evaporate materials that have a particularly tough corrosion problem; and in other fields far divorced from its pickling application.

While the older installations are still operating, day in and day out, the newer ones are proving that the low costs and high production figures made by early users were not isolated instances, but rather were indicative for the pickling field as a whole. Today, submerged combustion has taken its place in industry.

In plants where there was no room for pickling room expansion, these units have supplied the extra production for existing vats. Wise operating men, who know the danger of over-expansion, have found that these units can produce the needed tonnage and still give them the flexibility of operation and the minimum pickling costs, which are now so vital in the present readjustment period following the war.

Sixteen years ago, experiments were started on submerged burners for pickle room use. It was realized that the burners must be simple in design and fully automatic as to ignition and control of temperature, and above all should be rugged enough to withstand the treatment and corrosion conditions of the pickling room. As a result, all experimental work was done in the pickling room under actual working conditions. The results obtained from the first experimental burner were most encouraging; and from that point on, it was simply a matter of improvement and simplification.

Simply stated, this submerged combustion system consists of a control assembly designed so that the operator or watchman has only to press a starting button to put the entire unit in operation. Figure 1 shows a cross section of the burner. When the unit is shut down, the solution in the tank seeks its own level, completely filling the combustion chamber and a part of the burner manifold.

When the starting button is pushed, a gas-and-air compressor is started up. The compressor delivers the products of combustion at a pressure sufficient to overcome the head of liquid in the tank. As the compressed air is purging the burner of solution, the control system begins to operate. Automatically a hot wire igniter is heated to incandescence by the passage of a high amperage low voltage current, and after a predetermined time a flow of pilot gas is admitted to the burner where it is ignited. The main gas flow is then permitted to flow into the burner where it is ignited by the pilot flame. The air-gas ratio is automatically controlled to give maximum combustion efficiency. The burner might be classed as a nozzle mixing type with no possibility of back firing.

The burner plate is located beneath the solution level to insure the cooling of the combustion chamber by the surrounding liquid. The tubular combustion chamber conducts the heat and products of combustion down to and across the bottom of the tub where they

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are vented and distributed to give the rate of agitation desired.

Following the ignition of the main gas flame, the burner controls lock themselves into a running position until the desired solution temperature is reached. The thermostat then acts to shut off the gas flow and thus stop the heat in-put. However, the control mechanism is so designed that the air continues to flow through the system to maintain a fixed rate of agitation regardless of solution temperature.

When the thermostat registers a demand for heat, the controls recycle to automatically establish and ignite the gas flows. With the heat in-put so controlled, the solution temperatures can be maintained as close as one-half of one degree if necessary, but for the average department, the control range is usually set at from 3 to 5 degrees Fahrenheit.

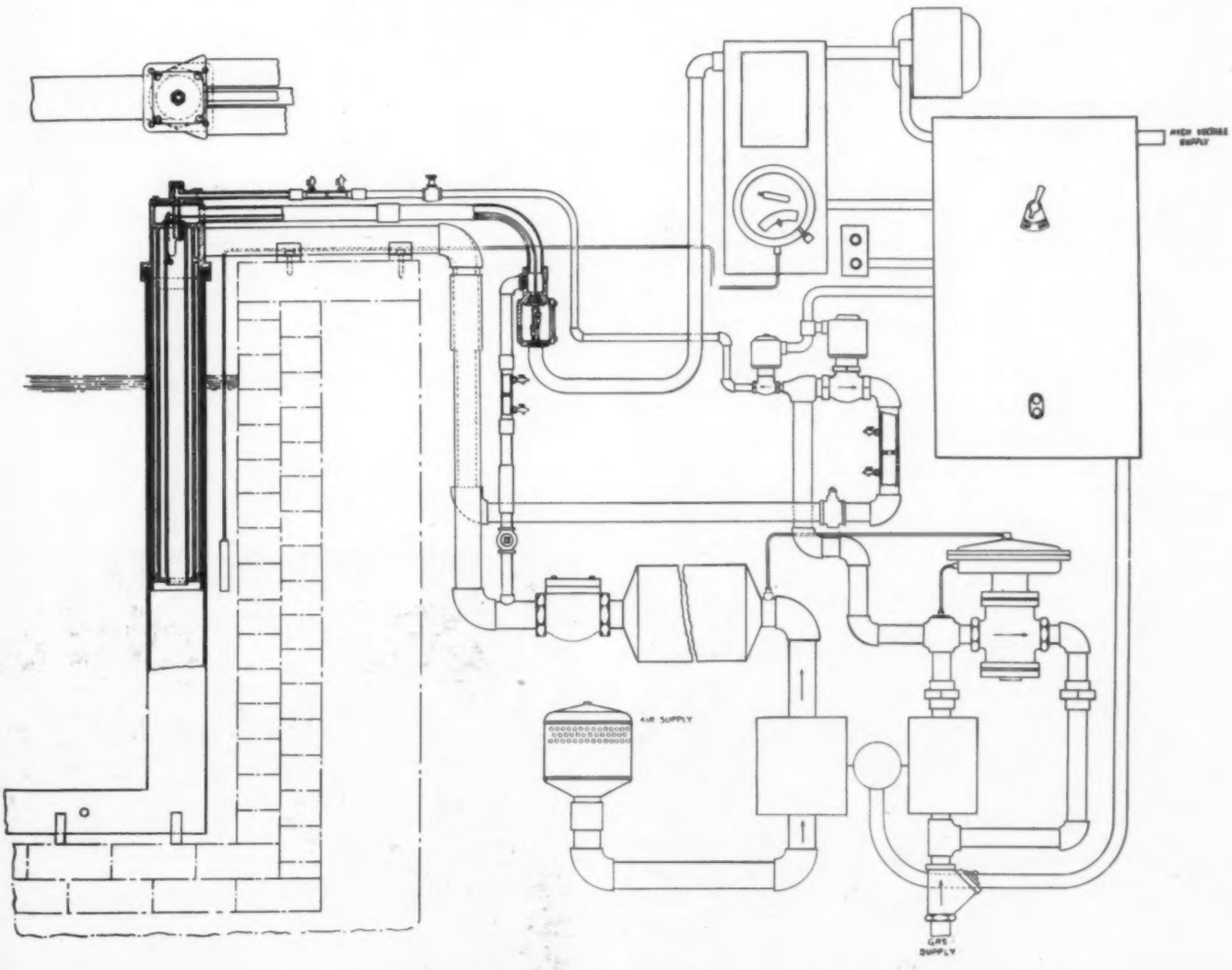
The combustion efficiency of these burners is high. The burners can be set to give any flue gas analysis desired. Orsat tests are run by inserting the end of a ¼ inch pipe into one of the exhaust holes in the combustion chamber and thus conducting the products of combustion to the orsat. The general practice in pickling is to set the burners for about five per cent excess air, but any desired flue gas analysis can be obtained.

Burners are supplied to either single or double units. A single unit consists of a compressor, burner, and the necessary apparatus for ignition and control. Rated capacity of the single units ranges from 250,000 to 8,000,000 Btu per hour.

In a multiple unit, two or more burners are connected to one compressor, the controls remaining essentially the same for each, so that each is independently operated and one or all of the burners can be shut off if desired.

Units of this type have a guarantee of material and workmanship for a period of one year, but the units have an expected service life of thirty months, when immersed in sulphuric or hydrochloric acid. In other more difficult acids, such as nitric and hydrofluoric mixed, or nitric and hydrochloric mixed, the guarantee period sometimes varies depending upon the strength of the acids; and the minimum any of these burners has ever had was six months, and even under these con-

Figure 1 — Cross-section of submerged direct-fired burner.



ditions the expected life was sixteen months. Even then the entire burner does not need to be replaced as the design permits sectional replacement of that portion which is attacked most quickly, namely the burner plate and bottom end of the burner tubes. This means rapid and economical repair without the loss of production, and without the necessity of having to carry expensive parts in stock. During the early days of development, many metals and non-ferrous materials were tested for use in the burner. All of those tried at first had some disadvantage for use with submerged combustion and three years passed before the metal was developed to meet the rigid requirements set for it. In the cross sectional figure of Figure 1, it will be noticed that the burner is protected from the agitated acid by a covering. In an earlier design the covering was not used, and the burner was subject to attack by 10 per cent sulphuric acid at 170 F while the burner was running.

Submerged combustion can be used to advantage in many applications of solution heating. It is especially adaptable to the rapid distillation and concentration of liquids. With a pH control it is an excellent water softener. It may be used to heat and agitate many types of cleaning solutions. However, one of the most practical applications for submerged combustion is pickling. As you all know, the rate of scale removal from steel is increased by agitation and aeration. Agitation may be accomplished either by moving the work while in the solution or by moving the solution about the work.

With submerged combustion, the products of combustion are exhausted directly into the solution. This creates a terrific agitation and the pickling solution, generally dilute sulphuric acid, is agitated and moved about the vat at a rate which would be extremely difficult to achieve mechanically. As a result, the average pickling time on various grades of steel is reduced 40 to 70 per cent of former practice if the operating temperature is held the same as it was with steam. The agitation also serves to keep the temperature extremely uniform throughout practically any size tank.

In general, the trend for pickling temperatures has been downward in recent years. The lower temperatures have much to offer where they can be used and still meet production demands. Pickling temperatures of 185 to 195 F are expensive from many standpoints. Surface heat loss at 190 F is almost twice that at 160 F. More heat is required to bring steel up to temperature and there is more dilution from condensation. Besides these very concrete cost factors, there is a much faster deterioration of handling equipment and building structure.

The only reason why many plants use temperatures of 185 to 195 F is because it is the only way they know to obtain the tonnage necessary to keep their machines supplied. However, the amount of tonnage obtained from a still tank heated with steam to 190 F can be equaled by submerged combustion at 160 F. The benefits in reduced heating costs and operating conditions from this lower temperature are obvious.

As you know, it is extremely difficult to obtain cost figures from various plants. Sometimes this is because they have no pickling cost system. In other cases, the management is hesitant about giving out definite cost figures for their particular operations.

We have been fortunate, however, in obtaining some figures on a few of our customers. Naturally, we are permitted to use these figures only if we do not name the customer in public. Before we give any definite figures, however, we would like to give generalities which we have received from some of our customers, which in itself shows savings by using direct fired equipment. One customer, pickling sheets, has sent us this report: "Pickling which required 20 to 25 minutes is now reduced to 5 minutes. Other materials which required as much as 45 minutes are now finished in 12 minutes. Although we have not checked the acid content as yet, we feel that there is quite a saving."

In another organization where tubes were pickled, we have the following customer's report. This letter was written by a user of submerged combustion in answer to a request from a friend for information regarding direct fired burners.

"With regard to the submerged combustion unit, I do not understand why you did not know we had such an equipment. I have been with this company over four years, and they had the unit about 6 months before I took over. It has been in continuous service since its installation; and as far as I am concerned, does work that no other equipment, regardless of cost, can do. The flow of acid through the interior gives practically the same efficiency of pickling as we naturally get on the outside.

I tried very hard to sell the idea to my old employer when I was there, but anything new was hard to sell them. I was very pleased when I took over here to find the equipment installed; and, of course, was grateful to find that my judgment was born out by its performance.

"You have had very elaborate agitating equipment installed, I know, and your maintenance probably was high. Here you have no running parts in the bath; and with reasonable care, the life of the unit in the tub is almost indefinite. To say there is no maintenance is of course silly; but per ton of material produced, there is a great savings. This method of heating also saves

Figure 2 — These two submerged combustion units have a capacity each of 2,000,000 Btu per hour and are used for pickling billets.

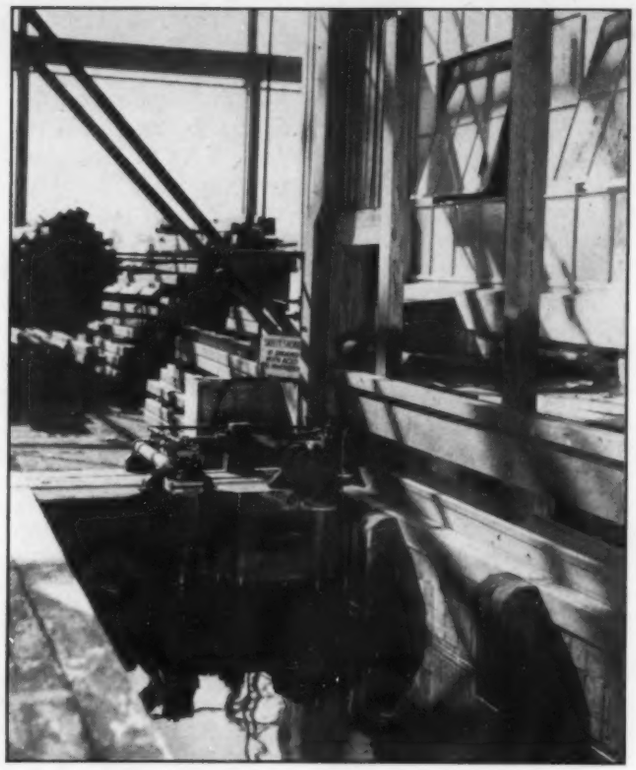


Figure 3 — Close-up view of 2,000,000 Btu per hour submerged combustion unit in billet pickling tank in west coast plant.

acid since the action concentrates your solution while induction of live steam is continually diluting your tank.

"As to pickling time, let me say this. We pickle five tons of seamless steel tubes as received from hot mills in most cases in 20 minutes satisfactory for mandrel drawing. Some very bad cases have taken us 35 minutes; however, at my old place I have known us to pickle with mechanical agitation two to three hours in stubborn cases."

It may interest you gentlemen to know that the total cost of repair and replacement parts in this particular job ran $1230.85 in four and one-half years of continuous operation. This cost included $525 for combustion chambers which were smashed or broken by careless handling of the tubes being pickled.

Another customer, pickling wire rod products, has recently written an article on submerged combustion equipment which has been in use in his plant since 1941. The following are quotations from that article:

"We had made two radical changes when we installed this equipment. First we cut out the old circle method of cleaning and installed a straight line cleaning system. Although we were not able to pickle any more yokes of wire at one time, we were able to get much more production per 8-hour shift. Our production rose from 50 tons in eight hours to 100 tons in eight hours. This production was obtained using seven yokes, each containing seven 300 lb coils. In addition to this increase in production, we were able to cut down the repickles which had amounted to approximately 10 per cent of our total pickling tonnage or five tons per day down to one ton per month. This alone shows considerable savings in money and time.

"We are now operating at a temperature of 170 F while with steam our normal operating temperature was approximately 190 F. We have no dilution in the steam, rather we have a concentration because of the evaporative effect of the equipment. These are our advantages in the straight line rod cleaning equipment.

"In the fine wire cleaning department we have found an additional advantage over the ones mentioned previously. As you know, lime clings to the surface of steel after drawing even though it is not normally seen. With submerged combustion, however, a reaction takes place between CO_2 which is a product of combustion, and the lime on the steel. This reaction seems to remove the lime from the steel and precipitates it to the bottom of the tank. This is proven by the residue found in the bottom of the vat as well as the crusts which form in certain cases around the burner ports of the combustion chamber. We have been fortunate in this reaction because the lime is not sufficiently heavy to completely close up these ports, although it is necessary to clean them whenever the tank is dumped.

"We now have three burners in operation. The first burner was placed in operation in March 1941 and up through August of this year has given us five years and five months of service. The second burner was placed in operation in July 1942 which is four years and one month of service. The last burner, which was placed in the fine wire cleaning department, was installed in August 1943 and has now given us three years service. This means a total of 12½ burner years.

"To date then, each burner has cost us $70.93 per year for parts. This we do not consider to be high because of the conditions under which this equipment operates."

Other customers have likewise praised this direct fired type of equipment. I do not believe you would be interested in reading all of them. The few I have given you should give you an idea of the possibilities of this type pickling equipment.

Let us now look at some definite production figures. In many places, pounds per man hour are given in place of total production figures because of the extreme fluctuation of business during the past 15 years. In making a comparison of this sort, it must be remembered that an excellent figure in one plant may be considered

Figure 4 — Submerged combustion gives a great deal of agitation in the bath.

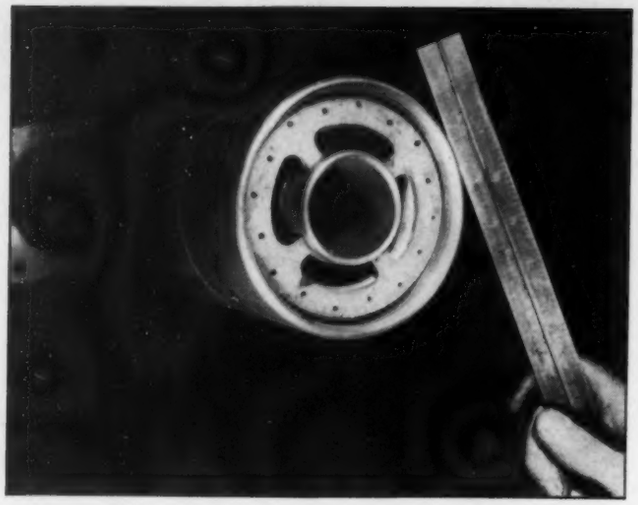


Figure 5 — Detail view of burner nozzle.

poor in another, depending on the set-up. For this reason, the following pounds per man hour are good only as a comparison of "before and after" the use of submerged combustion.

In this particular plant using steam as a heating medium, there were two coil pickling tanks, one holding two pins and one holding five pins of coils. In 1928, 1929, and 1930 when opening steam jets were used to heat the solution, the average pounds per man hour during this three year period was 1916. In 1931-34, one of the tanks was equipped with submerged combustion as an experimental measure. In this same period, the burner was running approximately 50 per cent of the time. Even this small aid with submerged combustion increased the pounds per man hour to 3,129.9. This shows a decided increase. In the following succeeding years, the pounds per man hour rose steadily until a peak was reached during the war years with a pounds per man hour of 8150. This figure itself denotes tremendous increase in productivity by submerged combustion equipment, but it does not tell the entire story.

In 1934 the average hourly rate in this shop was 53.4¢, while in 1943 this rate rose to 97.5¢; and yet in these same years, the labor cost per ton was reduced from 36.4¢ to 23.9¢. These are the type figures which show a definite reduction in pickling cost; and it is this type of figure which is important to production men who are interested in showing low figures on cost sheets.

In this same plant, the acid costs were likewise reduced. I would like to point out at this time, however, that the acid cost is the total acid cost of the plant and is not separated into the wire and bar departments. The wire department, however, does approximately 10 per cent of the total tonnage of the plant, the balance being cold finished steel bars. In this case before submerged combustion equipment was used, the yearly acid cost per ton ran as follows: 29¢, 30¢, 27¢, 34¢, and 27¢. Immediately after the entire plant, both bar and wire pickling departments, were equipped with submerged combustion burners, the acid costs per ton dropped to the following figures: 17¢, 19¢, 20¢, 18¢, 14.7¢ and 15¢. These figures show the possible savings in acid which can be gained by using direct fired burners.

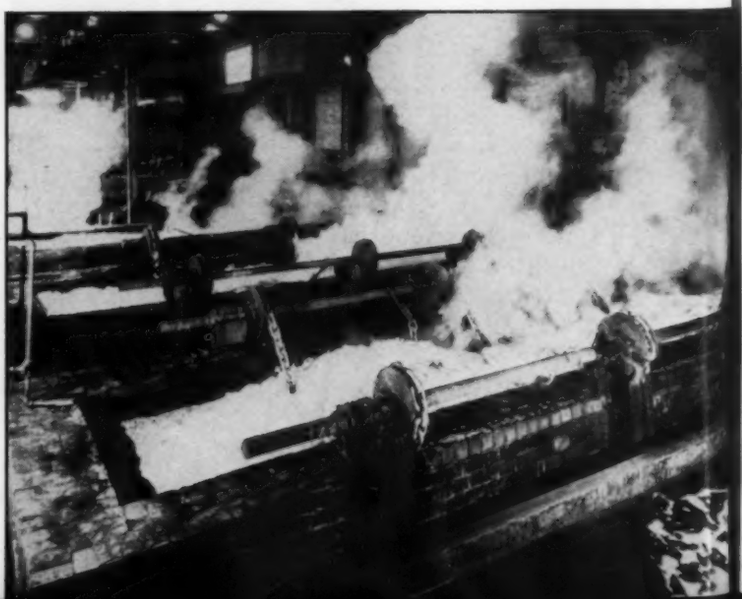
The following figures on bar pickling may be of interest. Using steam as a heating medium, the maximum pounds per man hour was 6,746.6. When submerged combustion equipment was installed, this figure rose until a maximum figure of 10,374.9 pounds per man hour was reached in 1944. In this same period, the average hourly rate rose from 78.1¢ to 95.3¢, while the labor cost per ton dropped from 34.9¢ to 24.7¢. These figures are taken over a twelve year period. It must be admitted that figures for single years can be doctored to suit one's purpose, but with figures taken over a twelve year period, the answers must be correct.

One additional figure on bar pickling is made with the comparison of steam heated mechanically agitated tubs against submerged combustion heated mechanically agitated tubs. When steam was used, the total average pounds per tub hour for one year was 9542. With submerged combustion in the year 1944, this figure jumped to 26,138 and in 1945 went up slightly to 26,215 pounds.

In bar pickling, one organization reports that the authentic figures available giving a year's comparison operating on steam as compared with a year's operation with submerged combustion, showed a steam cost of 45¢ per ton as compared with 13¢ using natural gas at 75¢ per million Btu. In the same periods, acid consumption dropped from 23.1¢ to 18.4¢, a reduction in cost of 4.7¢ per ton or about 20 per cent. In this particular case, the pickle bath temperature was brought down from 185 F with steam heating to 155 F with submerged combustion, along with an increased pickling speed of 20 per cent.

Another organization, pickling sheets with submerged combustion, is extremely fortunate in that they have a very low gas cost. Their gas costs them 20¢ per million Btu. When they were pickling with steam, their steam charge was placed at 35¢ per ton of steel pickled. This charge was not as arbitrarily made as most such figures. It was based on a reasonable run with a steam meter in the line to get the actual amount of steam required. Using submerged combustion in this tank, they lowered

Figure 6 — Battery of pickling tanks heated by submerged combustion.



their heating costs to 1.5¢ per ton of pickled materials.

In one plant we are now producing 168,072 tons of pickled steel for the same acid figure as they previously pickled 67,252 tons of steel. There has been no allowance made in this figure for the increase in acid costs which have been made over the eight year period from which these two figures were taken.

We have not considered in this paper the advantages in evaporating with submerged combustion, but we feel that submerged combustion can readily be used to evaporate waste pickle liquor and in so doing eliminate quite a few headaches that management now has with the various states passing stream pollution bills. Even without using submerged combustion for evaporating the waste pickle liquor, the lower acid consumption effected by submerged combustion means less used acid to be hauled away or otherwise processed.

Further, due to the evaporating effect of this burner, solution level can be allowed to drop before tub dumping time so that even less used acid will have to be hauled.

It is only natural that the generation of heat right in the solution should result in decreased heating costs, as the heat needed for each vat is generated in that vat. This means complete independence of a central boiler house whose efficiency falls off at anything under full load rating. In many plants, the boiler is run in the summer only for the pickle room. Submerged combustion burner in acid vats and immersion heaters in the lime solution or alkali tanks permits the boiler house to be shut down completely during warm weather for even greater savings in heating costs. In fact, one plant operating under these conditions found it advantageous to discontinue operating the boiler and to heat the plant with a coal fired hot air system.

In concluding this production discussion, let me summarize the advantages which can be effected by the use of submerged combustion burners. In many cases these advantages develop a total savings of about 50 per cent of present pickling costs. Production is increased and labor costs are decreased proportionately. Acid is saved and the number of rejections due to improper cleaning are reduced, and a more uniform product is obtained. Most users are able to retire the initial cost of the units in one year from the savings effected by their use.

DISCUSSION

PRESENTED BY

WILLIAM N. HORKO, Engineering Department, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania

W. G. SEE, Chief Engineer, Submerged Combustion Company of America, Inc., Hammond, Indiana

A. G. PIEMME, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

W. TRINKS, Associated Engineers, Pittsburgh, Pennsylvania

William N. Horko: What burner pressure is used?

W. G. See: It varies with the depth of solution in which the burner is placed. We use a rotary air compressor and a rotary gas booster, which deliver the pressure sufficient to overcome the head of liquid in the tank and that is all. We are only interested in obtaining a definite volume of air and gas, not a definite pressure. The pressure is determined by the requirements of the tank. We have units in operation in tanks up to 18 feet deep, in which our air compressor is 11 pounds. That gives us 9 pounds to liquid solution, one pound for draining the lines and burner, and an additional pound, which is sometimes required by the heavier solution as the iron builds up.

Member: Have any of these ever been installed in continuous strip pickling?

W. G. See: We have at the present time four units in one continuous pickling set-up. We do not have any figures available on that job as yet; it has been in service about thirty days. We have had to move the position of the burners, because of the agitation, which was forcing the acid over one side of the tank. We have recently moved the burners to the center of the tank, where we have corrected the acid spill, but we do not have any figures on the pickling, or any cost or production figures as yet. I feel that we have possibly another four or six weeks' work before we get the installation corrected and then it will be some time before we have production or cost figures.

A. G. Piemme: At what temperature are you operating?

W. G. See: We are operating the four continuous tanks, at approximately 178 to 180 F. According to reports, and I should say that this is entirely by word of mouth as I have no confirmation on it, their pickling foremen have informed me that they are maintaining and in some analyses bettering their previous pickling tonnage, which was done at the usual continuous strip temperatures of approximately 200 F.

Member: You are probably aware that in continuous strip pickling the tank design has changed appreciably in the past few years. Is that submerged combustion burner applicable to the old type free tank?

W. G. See: Yes. The main difficulty with the one just mentioned was due to slots in the tank in which they had inserted rolls, to keep the steel in the solution. They did not have any brick protection over the concrete. They mounted those rolls directly on the concrete and bricked around them. The acid splashes got up under the rolls and got in between the concrete and the brickwork, and it was causing difficulty in the tubs. That was our reason for moving the burners. It was purely, I should say, a structural defect in the tanks.

Member: Do you have any figures, comparative figures, on the steel loss between steam agitation and the submerged combustion agitation?

W. G. See: We have never checked those figures, but I can say this about an organization that has been using this equipment on test work, and finally on 100 per cent operation of their entire pickling departments. There is no difference in the scrap percentage in the plant today over what they had previously.

Does that answer the question that you asked? If you are speaking strictly of pickling metal loss, we have no figures on that.

Member: What size tanks?

W. G. See: The tanks in this particular case are two sizes. Three are 41 ft 6 in. long, 5 ft 0 in. deep and

6 ft wide. The other tank is 19 ft 6 in. long, 9 ft 6 in. wide, and 6 ft 0 in. deep.

Member: You stress this low temperature pickling. What temperature can you obtain with this?

W. G. See: The theoretical maximum temperature that can be obtained with submerged combustion is 196 F, according to scientists' figures. According to my figures, it is 192, but actually the best temperature we have ever obtained is 186 F. In tank work we have obtained and have been able to maintain temperatures that are between 170 and 182 F.

In submerged combustion work, when you are using this equipment in pickling, you cannot put too much burner capacity in any given tank because of the agitating effect of the exhausted gases. If you get too much capacity, you cannot hold the solution in the tank. Normally we will get a six to eight inch rise over the burner in the tank. Niagara gorge is the best way to explain the action of the acid in the tank using submerged combustion.

If you put a burner crosswise to the tank, your normal agitation is directly up from the combustion chamber across the surface of the tank to the opposite wall, then down, and back along the bottom of the tank to the chamber. If you take a long tank and run your combustion chamber lengthwise, i.e. along one side of the tank, the agitation is up, across the top to the opposite side, and then down to the bottom and back to the chamber. In any tank, two-thirds of the distance from the top of the solution down, the solution moves away from the burner, the lower third moves back to the burner.

To the best of our knowledge, there seems to be no quiescent zone between these different directions. In all pickling of bars or anything we have done, we get the same pickling condition in all sections of the tub.

Member: In continuous strip pickling, how would those submerged elements be placed in the tank, lengthwise or crosswise?

W. G. See: In continuous strip tank, lengthwise, one burner at the end of the tank where the strip enters. With some of the larger wider tanks, where more burner capacity is needed, one burner would run the first third of the tank, and a second burner one-third of the way down the tank. The strip itself would aid in distributing the heat. Normally, in a 40-foot tank with one burner at one end, there would be an eight degree differential in temperature from end to end. In some continuous tanks, which are 65 feet long, one burner would not be sufficient. An additional burner would be required to give the required heat, and the steel would distribute the heat down to the end, and would maintain even temperatures throughout the tank. It works out very well.

Member: What would happen in the event of a pile-up in that tank?

W. G. See: That is a question I cannot answer.

Member: You would possibly lose your middle burner and kill the other two.

W. G. See: You probably would. You would tear out the combustion chamber. In one set-up, which I just spoke of, we have done this since we moved the combustion chamber. We put this combustion chamber in the center. It was originally on one side in a corner, but we got splash-over to one side, which was causing tank trouble. So we moved the burner to the center and put in a brick wall. Now we intend to cover the burner trench, and split the agitation two ways.

W. Trinks: I am not clear about the location of the burners. Does it mean that you have to make the tank wider than it would have to be if the burners were not there?

W. G. See: In some cases, yes; in most cases, no, because in the majority of tanks we have run into so far, there is sufficient room to place the burner in the corner. The burner itself, with the largest combustion chamber we use in the pickling industry, is eight inches in diameter, so we only require a small section in one corner of the tank. In a continuous tank, that corner isn't used anyway, because the steel is usually coming over a roll at this point.

Member: Have you ever tried equipment using fuel oil?

W. G. See: Our patents cover fuel oil, but we do not use fuel oil in acid pickling. There are two reasons for that, the main one being, when you shut the burner down the solution seeks its own level within the combustion chamber and the fumes from that hot solution feed back through the lines, where the salts settle out at the various orifices. Under these conditions, the fuel setting is constantly changing. With fuel oil, if you don't run a perfect flame at all times, you will get stringers. Stringers would be bad in a pickling tank, because they would stick to the steel when it was removed from the tank and the stringers could not be removed except by hand wiping.

Member: What are stringers?

W. G. See: Stringers of unburned oil. They would come out on your material as long black strings of oil.

Member: In other words, you can't use oil?

W. G. See: That is right. You can't use oil in pickling.

Member: Your burner then, Mr. See, does not apply itself very well to dirty coke oven gas?

W. G. See: Dirty coke oven gas in submerged combustion burners is just as effective as dirty coke oven gas in any automatic burner. Our main difficulty, of course, is the solenoid valves which stick, but as far as the burner itself being plugged up, there is no difference than in any other burner.

Member: You spoke of your control system. How elaborate a control system is required?

W. G. See: Do you mean, is the control system in the acid room where you will have difficulty with it? Are you working from a maintenance angle?

Member: That is right.

W. G. See: We have two different sections of controls. One is called our main control panel, which contains a starting switch, safety switch, timers, relays and covers the entire operation of the burner. It can be placed as far away from the pickling tank as you wish to run your electric wires.

The second control panel has in it a small transformer for the ignition element and the temperature control. This can be, and is placed as close to the pickling vat as possible. They last indefinitely.

Member: Your temperatures are considerably below the average pickling temperature for continuous strip pickling. Will you explain that, please?

W. G. See: It is the highest we can get. I believe

any one who has had a lot of experience in pickling will agree with me when I say that temperature and agitation are more or less interchangeable in pickling. If you have a heavy agitation you do not need as much temperature to get as much steel out of the tank. Our agitation is much heavier than anything you have ever seen in a pickling tank before. Normally I would say the solution rushes across the top of the tank and through the body of the solution, three to four miles per hour. It moves. It doesn't just flow along; it moves.

Member: Why?

W. G. See: Because the products of exhaust are thrown directly into the solution. If you are throwing steam into that solution, it will condense and turn to water and lose its push. When you throw gas or air into the solution, it maintains its own body and seeks the atmosphere, so it goes to the top, and as it moves upward, the surrounding solution goes into the void, and starts circulation. Is that the answer to that "why?"

Member: You could agitate with cold air then?

W. G. See: Yes, but if you are thinking of agitating with cold air and using steam as the heating medium, you are getting into considerably more steam cost. You can agitate with any air, just as well, as far as agitation is concerned, but as far as the economics is concerned, the answer is no.

W. Trinks: I do not understand Mr. See's answer. I believe that I could install a furnace big enough to evaporate the whole tank.

I think what he means is this: It is the highest temperature which we care to have, because if the tank is operated at a higher temperature, the gases carry out so much of the liquid that there is nothing left.

W. G. See: No, because of Dalton's laws of mixed gases and vapors in an aqueous solution, the highest temperature you can get theoretically is 196 F and the highest we have ever been able to get was 192 F. To do this, we have had to put a million and a half Btu per hr into a 30 square foot surface tank with about three or four feet of solution.

W. Trinks: In other words, it is not a question of water; it is a question of the pickling solution.

W. G. See: It is a question of the specific gravity of the solution, yes.

ANALYSIS OF CENTRALIZED LUBRICATING SYSTEMS

By JAMES P. GRAVENSTRETER

(*Continued from page 89*)

tained when several small centralized systems are used to dispense different lubricants than when one so-called all purpose lubricant is supplied by one big system.

9. After a system is in service it should be serviced by higher calibre help than is ordinarily used to perform hand lubrication.

The author hopes that the foregoing information on the design and operation of the various systems discussed in the paper has proven helpful, to both operators and engineers, and that they may use it as a guide to aid them in making a better selection of centralized lubricating systems for their machine equipment.

DISCUSSION

PRESENTED BY

R. A. KRAUS, Lubrication Engineer, Republic Steel Corporation, Chicago, Illinois

R. A. Kraus: Considerable detail has been offered in Mr. Gravenstreter's paper by way of comparison, with the result that a composite view of the entire field of centralized lubrication as of today is readily available. Obviously this would be of considerable value to those who are only vaguely familiar with many of the types of systems offered to the present day purchaser. However, there is still no general answer to all problems, and experience in the method of installation is frequently as big a factor in the success story of centralized lubrication as is the selection of the system initially.

Mr. Gravenstreter touched only lightly on the subject of subsequent maintenance of the centralized system after installation. This feature should not be casually overlooked since much of the successful or inferior operation of the system as a lubrication device will depend upon the maintenance each system receives after installation. Too often a system is condemned as "no good" when in reality the fault lies primarily in the maintenance the system has received. A few broken lead lines or leaky main lines, which subsequently cause burnt out bearings, can obviate the good possible from the most intelligently chosen centralized lubrication system. Frequently the trouble goes back to the original installation at which time the possible damage from mill operations or mill maintenance was not properly investigated and forseen, and as a result smashed lines could not be prevented due to poor selection of line and feeder locations, etc. Good engineering is needed when installing systems on equipment not originally designed for modern lubrication in order to prevent much of this predictable damage. If installation procedure is carefully watched and if the proper type of system is selected for each job, considerable benefit can conceivably be obtained by all personnel concerned.

SURGE VOLTAGES IN S

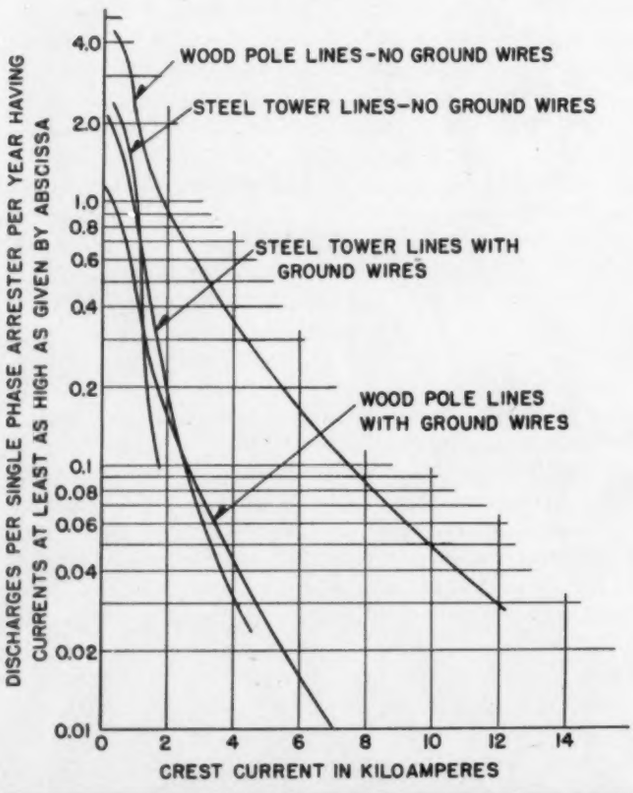
. . . . distribution circuits of most plants are fairly well shielded from direct or induced lightning surges, but lightning protection is generally required at the substation connecting the circuit to the exposed higher voltage circuits which feed the plant system . . . .

▲ ELECTRIC power systems are subjected to abnormal overvoltages of three principal types. These are sustained system faults, lightning surges and system transients, the more common forms of the latter being transient recovery voltages resulting from the extinction of a fault, switching surges, and arcing grounds. In addition, some systems are subject to overvoltages from such causes as overspeeding waterwheel generators, harmonic overvoltages from short circuits on rotating machines without properly designed amortisseur windings, or flashovers from higher voltage circuits. These however are uncommon to industrial distribution systems which will be the principal subject of this paper.

Sustained fault voltages, often the result of a transient disturbance, seldom reach dangerous magnitudes from the standpoint of insulation failure. Their importance lies in the determination of the rating of applied lightning arresters. Since most of the larger power systems are exposed to lightning, lightning surges are the principal cause of dangerous overvoltages and system faults. Thus the principles of insulation protection have developed principally from the viewpoint of lightning surge protection. However, during the past eight or nine years important studies have been made of system transients both on actual circuits[1]* and by means of the a-c network calculator.[2] Although most of these have been principally from the point of view of transmission and open wire distribution systems rather than the cable circuits typical of some industrial plants, certain significant factors have been determined for all types of systems that have led to reduced faults and insulation failures from such causes. The characteristics of system transients are determined in a large measure by the electrical constants of each system's particular grounding conditions. The most significant knowledge gained from the system transients studies has been with regard to the effects of different types of system grounding and the magnitude of grounding impedances. Lightning arresters of both the valve and "de-ion" principle and rod gaps, instruments developed for lightning protection, are still the principal devices for the general limitation of overvoltages. However, shunt capacitors, used first for lightning protection of rotating machines, have found a place along with grounding devices in the limitation of certain types of system transient voltages.

*Numbers refer to corresponding references in bibliography.

Figure 1 — Effect of line construction on number and magnitude of station arrester discharge currents.



COMPARISON OF APPARATUS INSULATION LEVELS

Before discussing in detail the characteristics of the various types of surges and surge protection, it might be well to compare the insulation strengths of various classes of apparatus. Insulation design and dielectric tests have been based primarily upon power frequency and lightning surge voltages. Insulation strength for system transients which generally have frequencies between a few hundred and a few thousand cycles per second lies in between these but usually closer to the power frequency strength of the insulation. It is therefore considered that switching surge voltages and the like should be kept below the 60 cycle strength of the insulation.

In recent years it has been the practice to standardize as much as possible the impulse strength of all station equipment subject to lightning surges bringing them above minimum "basic impulse levels" that have been established. These are listed in Table I for voltage

Presented before Pittsburgh Session of Annual Meeting, September 26, 1945

N STEEL MILL CIRCUITS

By G. D. McCANN

CONSULTING TRANSMISSION ENGINEER

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EAST PITTSBURGH, PENNSYLVANIA

classes up to 34.5 kv. A comparison of the power frequency and impulse strengths of various classes of apparatus is given in Table II for operation on 6900 volt circuits. As shown by Table II all but dry type transformers and rotating machines have impulse levels above the basic value of 75 kv. These two types of equipment are seldom used where they have much lightning exposure. However, by special protective methods they can be given adequate lightning protection even in exposed locations. As shown in Table II the power frequency strength of the insulation varies from 3.7 times normal line to ground operating voltage for rotating machines to over 9 for insulators. Thus rotating machinery is the most vulnerable from all types of overvoltage conditions.

Table III compares the protection afforded by the four classes of valve type lightning arresters available for the apparatus of Table II. As shown even the full rated standard arresters for ungrounded circuits provide an ample margin of protection for all but dry type transformers and rotating machines. Tables IV and V list the insulation levels for all voltage classes of dry-type air-cooled transformers and rotating machines together with the protective levels of the special arresters recommended for their protection.

TABLE I

STANDARD BASIC IMPULSE INSULATION LEVELS FOR DISTRIBUTION CIRCUITS

Reference class — kv	Common operating voltages — kv	Basic impulse level — kv
1.2	.....	30
2.5	2.4	45
5.0	4-4.8	60
8.7	6.6	75
15.0	11-13.8	110
23.0	22-25	150
34.5	33	200

LIGHTNING PROTECTION

The discussion of lightning protection given here will be confined primarily to substation and distribution circuits typical of those of industrial plants. The distribution circuits of most industrial plants are fairly well shielded from either direct or induced lightning surges and most disturbances originate on those higher voltage circuits that may feed such a system. In general, therefore, most lightning protection is concentrated at the substation connecting to the exposed lines.

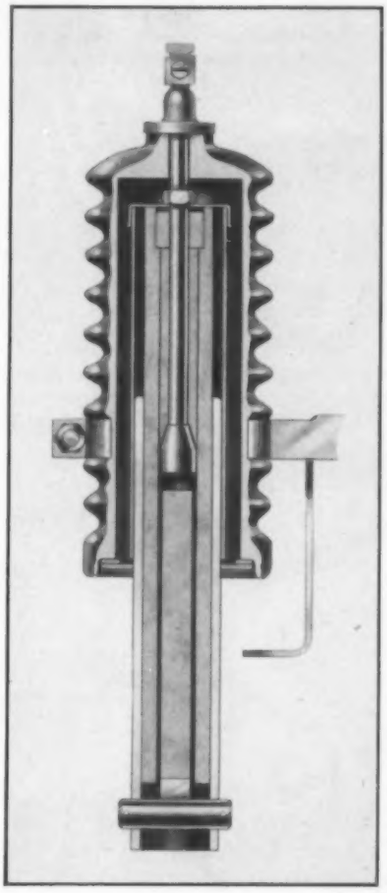


Figure 2 — Typical cross-section of "de-ion" protector tube lightning arrester.

Substation protection — The frequency and severity of lightning surges appearing at substations is a function of the exposure of the feeding lines, their degree of protection, and their insulation level. Unprotected wood pole lines with high insulation to ground permit higher magnitude surges than lines with lower insulation, lines protected with overhead ground wires, or lines protected with "de-ion" protector tubes. For transmission lines in voltage classes above 115 kv with well applied overhead ground wires and low tower footing resistance (below 10-20 ohms) the probability of dangerous voltages reaching a substation does not exceed about once every 10 years. Some utilities feel that station protection is not warranted under these conditions. However, for

TABLE II

COMPARATIVE TEST INSULATION LEVELS FOR APPARATUS TO OPERATE AT 6900 VOLTS — BASIC IMPULSE LEVEL 75 KV

Type of apparatus	Rating kv-rms	60 Cycle — 1 Min test		Min impulse† kv-crest
		Kv-rms	Times normal*	
1. Outdoor insulators	7.5	35	8.9	145
2. Bus support insulators — outdoor	7.5	36	9.0	100
— indoor	7.5	26	6.6	....
3. Current limiting reactors — oil	8.7	29	7.3	110
— dry	8.7	40	9.9	....
4. Bushings — outdoor — large apparatus	8.7	35	8.8	95
— outdoor — small apparatus	8.7	27	6.8	75
— indoor	8.7	30	7.5	75
5. Circuit breakers:				
Power — below 150,000 kva	7.5	26	6.6	75
— above 150,000 kva	7.5	36	9.0	95
Air circuit breakers	7.5	19	4.8	75
6. Transformers — oil insulated	8.7	26	6.6	95
Oil — below 500 kva	8.7	26	6.6	75
Dry type — air cooled[1]	8.7	19	4.8	35
7. Cables[2] — Solid paper	8.7	....	....	169
— Varnished cambric	8.7	....	....	142
— Rubber	....	....	....	68
8. Rotating machines	6.9	14.8	3.7	20.9

*Times normal line-to-ground operating voltage.
†Based on 1½ x 40 microsecond standard test wave.
[1]See reference. [2]See reference.

TABLE III

COMPARATIVE PROTECTION LEVELS AFFORDED BY LIGHTNING ARRESTERS FOR OPERATION AT 6900 VOLTS

Type of arrester	Voltage rating kv-rms	Gap breakdown		IR discharge voltage on 10 x 20 microsecond current wave kv-crest	
		60 cycle kv-rms	Impulse kv-crest		
Standard valve type arresters				1500 amp	10,000 amp
1. Station type —					
for ungrounded systems	9	23	35*	27	33
for grounded systems	6	14	23	18	22
2. Line or distribution type —					
for ungrounded systems	9	25	52	38	50
for grounded systems	6	15	35	25	34
Special valve type arresters for rotating machines and dry-type transformers				1500 amp	3000 amp
3. Special station type —					
ungrounded	9	21	30*-26†	27	..
grounded	6	13	22 -17	18	..
4. Special line type —					
ungrounded	9	21	33 -27	27	30
grounded	6	14	25 -18	18	20

*Front of wave breakdown of standard AIEE rate of voltage rise.
†Wave front of 10 microseconds to breakdown.

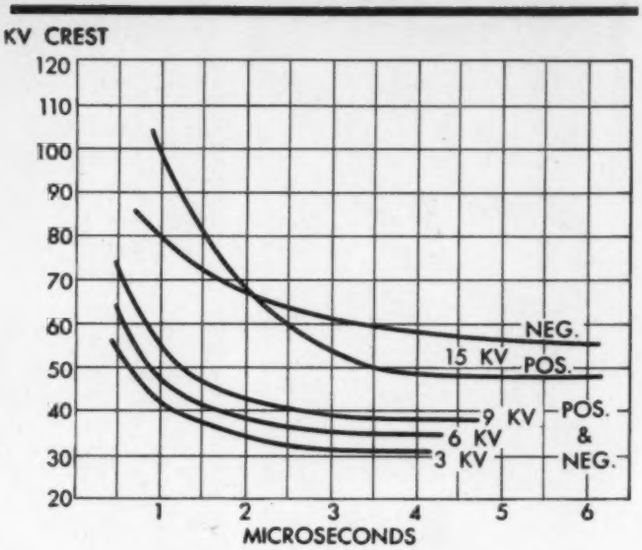


Figure 3 — Impulse sparkover time to sparkover characteristics 1.5 x 40 microsecond waves. Positive and negative are same on 3, 6 and 9 kv ratings.

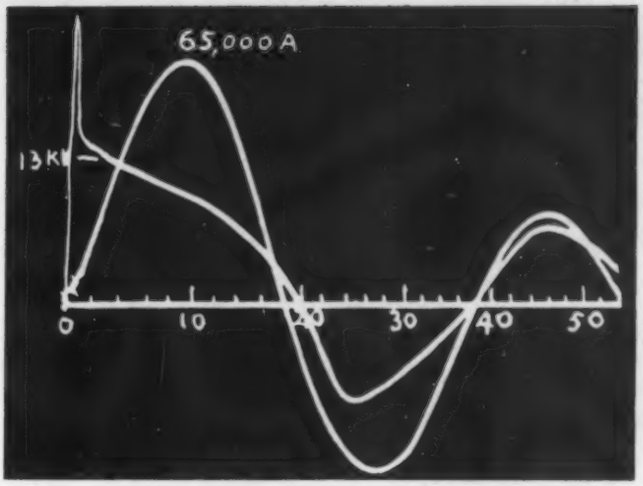


Figure 4 — A 9 kv Type A "de-ion" arrester discharging 65,000 amperes. The voltage across the arrester during discharge of the currents is 13 kv following sparkover at 55 kv.

lower voltage circuits in exposed lightning regions station protection is desirable. Figure 1 gives probability curves of the frequency of occurrence of lightning surges with a given crest current for both protected and unprotected lines. As shown, line protection can be expected to reduce the number of surges having a given crest magnitude about ten to one. For highly exposed lines this is desirable since the severe surges are not only more likely to produce dangerous voltage on station equipment even with well applied arrester protection but also may place severe discharge duty on the arresters. As far as station protection alone is concerned, the equivalent of a protected line can be achieved either by a short section of overhead ground wire extending about a half mile out on the line or one or more sets of protector tubes installed at intervals out from the substation. The number required depends upon how low their grounding resistance can be made. With ground resistances of 5 ohms or less, one set 500 feet out is sufficient. Ten ohms would require one set 1000 feet out or preferably two sets at 500 foot intervals for the same degree of protection. This scheme not only greatly reduces the possibility of severel high rates ofy voltage rise causing overvoltages at the transformer,

TABLE IV

INSULATION LEVELS OF DRY-TYPE AIR-COOLED TRANSFORMERS COMPARED WITH PROTECTION LEVELS OF TYPE "RM" AUTOVALVE ARRESTERS

Impulse Insulation Levels of Air-Insulated Transformers

Insulation class kv	Low-frequency dielectric tests kv-rms	Impulse levels 1½ x 40 ms wave kv-crest
1.2	4	10
2.5	10	20
5.0	12	25
8.66	19	35
15.0	31	50

Performance Characteristics of Type "RM" Arresters*

Arrester rating kv-rms	Phase-to-phase circuit voltage rating		60-Cycle gap breakdown kv-rms	Impulse breakdown in kv-crest		Discharge voltage kv-crest on 10 x 20 ms currents	
	Ungrounded neutral system	Solidly grounded neutral system		Front of wave**	1½ x 40 ms wave	1500 Amp	3000 Amp
3	2,400	4,160	6	13	9	9	10
6	4,800	7,200	12	24	18	18	20
9	7,200	11,500	18	32	27	27	30
12	.....	13,800	24	40	36	36	40
15	13,800	.....	30	48	45	45	50

*These arresters are special and should not be used interchangeably with standard distribution arresters.
**Test wave as recommended in AIEE Standards No. 28 for standard valve-type arresters.

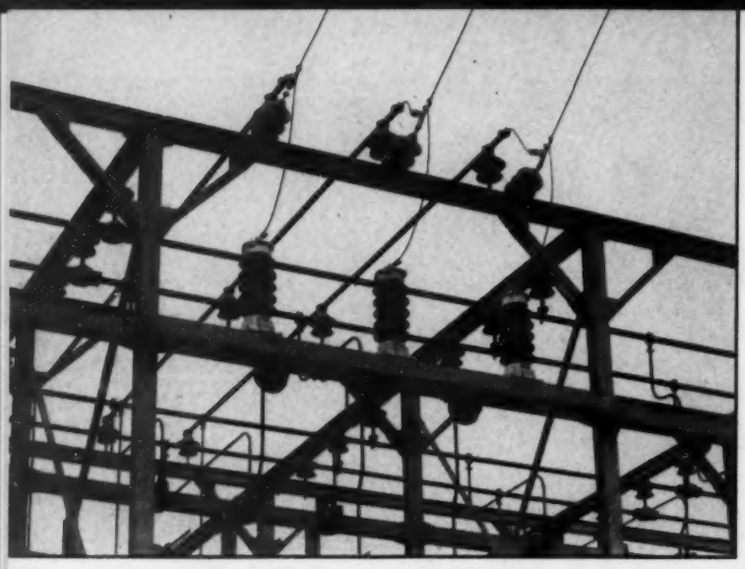


Figure 5 — Typical substation installation of station-type lightning arresters.

but reduces greatly the current at the station arrester so that it will not be damaged or permit too high voltages due to IR drop in the arrester in combination with the impedance of the arrester grounding circuit.

In the substation the power transformers are usually the most vulnerable and costly apparatus. Arresters should be located sufficiently close to them that serious overvoltages by reflections between the arrester and transformer terminals cannot occur. Arresters mounted directly on the transformer case are becoming more and more common. Cases where more than 75 to 100 circuit feet of lead exist between the arrester and transformer give questionable protection. In the more extensive stations where arresters sufficiently close to the transformers do not protect all other apparatus additional arresters can be placed at the incoming lines. However, in any case, sufficient protection of the bus structure and breakers is secured with rod gaps at the incoming lines coordinated with the transformer arresters.

Except in certain cases where dry-type transformers or rotating machines are connected to the lower voltage circuits fed from the station, lightning protection of the lower voltage circuits does not require low voltage

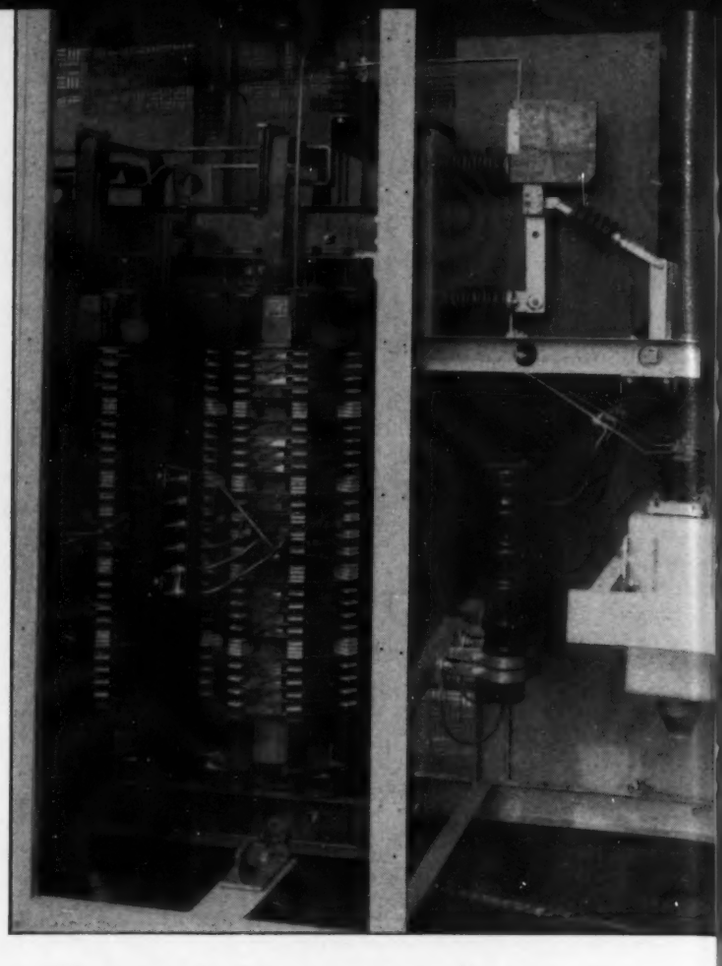


Figure 6 — Built-in lightning arrester protection in dry-type air-cooled transformer.

arresters where these circuits are not exposed to lightning.

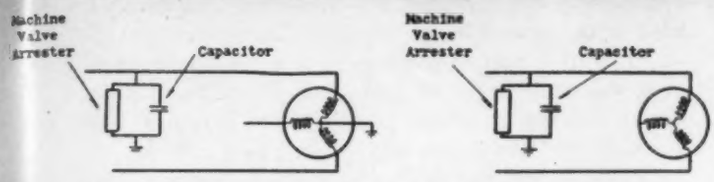
Cable protection — Cables connected to exposed overhead lines should be protected with valve type arresters or protector tubes connected at the line end pothead. To eliminate the effect of the arrester grounding resistance, the arrester grounds should be interconnected to the cable sheath. For cables over about 100 feet in length or less than about 2500 feet, reflections at the other end may pile up severe surge voltages at

TABLE V

PROTECTION LEVELS OF SPECIAL AUTOVALVE MACHINE ARRESTERS

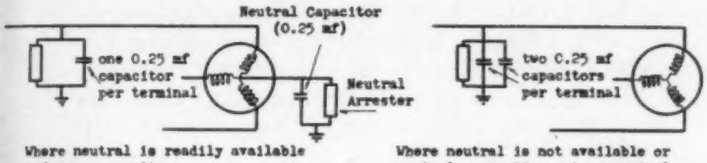
Machine voltage class	Std AIEE 60-cycle test kv-crest	Grounded neutral machine		Ungrounded machine	
		Terminal machine arrester rating kv	Gap breakdown kv*	Terminal machine arrester rating kv	Gap breakdown kv*
650	3.3	0.75	2.5	0.75	2.5
2,400	8.2	3	9	3	9
4,160	13.2	3	9	4.5	13
4,800	15	4.5	13	6	17
6,900	20.9	6	17	7.5	21
11,500	33.9	9	26	12	34
13,800	40.5	12	34	15	42

*Breakdown for wave with 10 microsecond front. These values are not exceeded by the arrester discharge voltages (RI drop) for currents of the order of 2000 amperes.



Machine Voltage Class	Surge Capacitors Microfarads	Surge Capacitors Voltage Rating RMS-Kv	Machine Valve Arrester Ratings RMS-Kv Grounded	Machine Valve Arrester Ratings RMS-Kv Ungrounded
For Grounded and Ungrounded Machines				
650	2.0	0.65	0.75	0.75
2,400	0.5	2.4	3.0	3.0
4,160	0.5	4.16	3.0	4.5
4,800	0.5	4.8	4.5	6.0
6,900	0.5	6.9	6.0	7.5
For Grounded Machines				
11,500	0.25	11.5	9.0	-
13,800	0.25	13.8	12.0	-

(a) For all grounded machines and for ungrounded machines up to and including 6900 volts. Arrester rating is determined by machine grounding conditions when mounted at machine, but upon system grounding when mounted at bus.



Where neutral is readily available and space permits.

Where neutral is not available or neutral protection not economical.

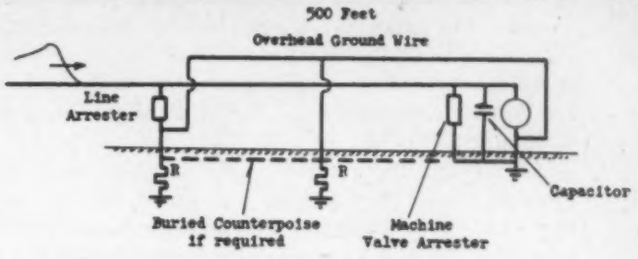
Machine Voltage Class	Terminal Equipment Voltage Rating in RMS-Kv Capacitors	Terminal Equipment Voltage Rating in RMS-Kv Arresters	Neutral Equipment Voltage Rating in RMS-Kv Capacitors	Neutral Equipment Voltage Rating in RMS-Kv Arresters
11,500	11.5	12	6.9	7.5
13,800	13.8	15	11.5	9.0

(b) For 11,500-13,800 volt machines with neutral floating, grounded through resistance or reactance exceeding 50 or 0.2 ohms, respectively, per 100 ohms of winding surge impedance. Minimum surge impedance can be taken as 100 ohms. If grounding impedance at 60 cycles is low enough that machine can be considered grounded from normal fault voltage standpoint, the arresters listed under (a) may be used at the terminals and those under (b) at the neutral.

Figure 7 — Apparatus requirements for lightning protection of rotating machines.

that end when valve type arresters are used. This is because the IR drop in the arrester may hold the surge voltage up long enough for the reflections to build up the voltage. However, this is not the case when protector tubes are used as their discharge voltage is quite low and no additional arresters at the other end are required if other exposed circuits are not connected at the other end. A new type of protector tube has recently been developed for voltages up to 15 kv that has an unlimited current interrupting capacity and low sparkover characteristics, so that it is suitable not only for cable and line protection but also distribution transformer protection. This device is shown in Figure 2 with its sparkover and discharge voltage characteristics in Figures 3 and 4.

Dry-type air-cooled transformers — Dry-type air-cooled power transformers are finding a wider and wider field of application since their introduction in 1936[3]. Intended originally for indoor use on unexposed circuits, they are now being satisfactorily applied to exposed circuits. However, as shown in Table II their insulation strength is necessarily somewhat lower than that of equipment for exposed circuits. As a result of experience on exposed circuits and a steady of their protection[3], it has been found that where used on exposed circuits they can be adequately protected with the line type of special rotating machine arrester. Its characteristics are listed in Tables III and IV. Except

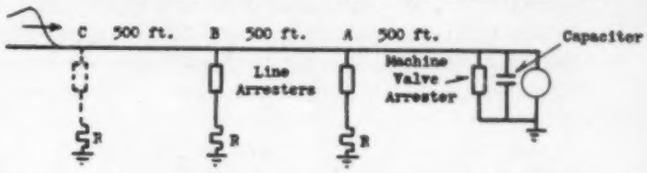


Maximum Permissible Pole Grounding Resistance, R in Ohms

Spacing of Pole Grounds	250 ft.	125 ft.
Type of Line Arrester		
De-ion	5-10	10-20
Valve	2- 5	4-10

If these resistances cannot conveniently be obtained with driven ground rods, buried counterpoise connecting line arresters to machine ground should be used.

(a) Cases where overhead ground wire is required for adequate shielding.



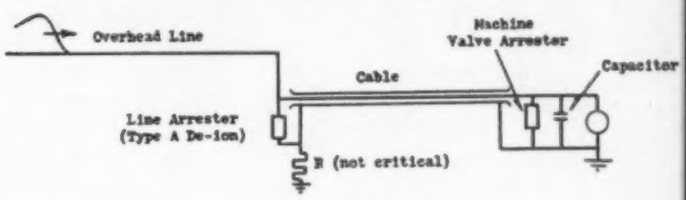
Type of Line Arrester	Maximum Permissible Line Arrester Grounding Resistance, R in Ohms Two Sets of Arresters at A and B	Three Sets of Arresters at A, B, and C
De-ion	10-20	20-40
Valve	5-10	10-20

(b) Cases where overhead ground wire is not used (strokes to line within 1000 feet may endanger machine).

Figure 8 — Recommended line protection methods for machines connected directly to overhead lines.

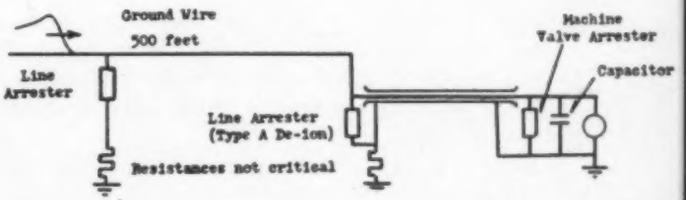
▲

Figure 9 — Recommended line protection methods for machines connected to overhead lines through cables.



Cable Surge Impedance in Ohms	5	10	25	50
Minimum Cable Length in Feet	2000	1000	500	300

(a) For cables sufficiently long that section of overhead line is not required for wave sloping.



(b) For cables longer than 200 feet, but not long enough to be classified under (a). Ground wire preferred but not essential.

(c) For shorter cables the protection methods of Fig. 2 are recommended with the addition of a set of "De-ion" arresters at the cable pothead.

for certain large and important installations, the use of the more expensive special station type arrester of Figure 5 is not considered justified as the other provides adequate protection. It is preferred that the special arresters be mounted right in the transformer as shown in Figure 6.

Arrester protection is not required for these transformers where they are on unexposed circuits or connected to exposed circuits through transformers properly protected on the line side, unless they constitute the only load on the power transformer and are connected either by a short open wire line or cable shorter than 50-100 feet. Under the latter conditions high surges can be transferred electrostatically through the power transformer. This case will be dealt with in more detail in connection with rotating machine protection.

In addition it is desirable that the lightning discharge current at the dry-type transformer arresters be limited to about 3000 amperes because of arrester IR drop. Where connected directly to highly exposed overhead lines this can be achieved by the use of one or more sets of line arresters as discussed above for station protection. When connected to a highly exposed overhead line through cable, the cable pothead arresters will achieve this purpose.

Rotating machine protection — Not only does the low line-to-ground insulation of rotating machines require special precautions, but the character of turn-to-turn insulation and the required configuration of the windings is such that rotating machines are the one type of apparatus for which additional protection methods are required to limit the rate of voltage rise across the windings. A rotating machine can be conceived as a transmission line with distributed constants, the essential difference being that the machine winding is wound back on itself which may permit high voltage across the turn-to-turn insulation. The installation of special arresters with low and consistent sparkover characteristics satisfactorily limit the maximum voltage that can appear across the terminals. However, capacitors are also required, which in conjunction with the inductance in the line, or added lumped inductance, slope the front of the wave to a safe value preventing a pile up of voltage across turns of the winding. The actual amount of wave sloping required varies with the number of turns per coil being greater the more the turns. For turbo-generators with fewer turns per coil, the amount of wave sloping required is not as great. Some turbo generators have one turn coils for which no capacitors are required. The most vulnerable machines to turn-to-turn failure are motors with large numbers of turns per coil. It has been found that a safe practice for all machines is to provide that the applied surge voltage of safe crest magnitude be sloped to a front of 10 microseconds. A detailed study of the methods of achieving this is given in reference 4, the results of which are summarized here.

While the protection required at the machine and on the line are mutually interdependent, it is possible to resolve the suggestions for machine protection into the four following categories.

1. *Protection at machine terminal or bus* — The ratings of valve-type arresters and capacitors recommended for each voltage class are listed in Figure 7 together with their method of application. It is important that arresters at the machine be valve type and always used with capacitors to prevent the occurrence of steep front surges resulating from a sudden voltage drop when the arrester discharges. When more than one grounded machine is connected to one bus through less than 500 feet of line, a single set of terminal capacitors and arresters may be used at the bus.

2. *Machines connected directly to exposed overhead lines* — Line type arresters must be placed far enough out on the line to chop the incoming surge which is sloped by the machine capacitance in conjunction with the intervening line inductance. The two methods shown in Figure 8 are recommended as providing the most effective and economical schemes for general application. The importance of low ground resistances for the line arresters is shown in this figure. This is necessary not only for satisfactory wave sloping but also to insure limiting the machine arrester discharge current to a limit of about 1500 amperes which as shown by Table III prevents dangerous arrester IR drops.

3. *Machines connected to overhead lines through cables* — The protection recommended for these cases are given in Figure 9. These assume that protector tube type arresters with low discharge voltages are used at the line arrester and directly grounded to the cable sheath.

4. *Machines connected to lines through transformers* — Lightning surges are transferred through transformers in two ways; electrostatically through the transformer capacitances, and electromagnetically. Machine protective apparatus should be used to protect against surges transferred electrostatically unless at least 50 to 100 feet of cable providing an effective capacitance of at least 0.005 microfarad per phase is connected to the machine terminals. Whether or not machine protection is required for electromagnetically transferred surges depends upon a number of factors too complex for treatment here (see reference 4). However, whenever machine arresters are used, capacitors should also be applied. Also inasmuch as the transformer leakage inductance is always sufficient for wave sloping purposes, line arresters are not required but station-type arresters should be provided on the line side of the transformer.

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ELECTRIC COUNTERWEIGHTS FOR INGOT STRIPPING CRANES

. . . . an ingenious modification of the usual circuit controlling a stripper crane causes the hoist motor to act as an electric counterweight . . . .

By R. J. HARRY

VICE PRESIDENT

ALLIANCE MACHINE COMPANY

ALLIANCE, OHIO

▲ THE modern push-pull, screw type stripper is designed to strip either the standard small end-up ingots or the large end-up ingots with hot tops.

In stripping the standard small end-up ingots, it is customary for the operator to lower the column and engage the lifting lugs on the mould with the lifting links which are pivotly attached to the column. He then raises the column and mould by the hoist motion of the stripper. In most cases the mould is removed from the ingot quite freely, and as the mould is raised by the hoist of the stripping machine, the ingot is left on the stool of the ingot car. The operator then continues to raise the hoist until the mould is lifted free from the ingot, and the mould is then deposited on the stool of an ingot car on an adjacent track.

Frequently in raising the mould, stickers are encountered and the ingot which adheres tightly to the inside of the mould is raised with the mould. It is then necessary, in order to remove the ingot, for the operator to bring the stripping screw motion into action. If the ingot and mould are raised an appreciable distance above the stool of the ingot buggy, as is frequently the case when a sticker is encountered, when the ingot is pushed out of the mould it will fall until it engages the ingot stool on the buggy. The impact from such a fall frequently results in the breaking of axles, anti-friction bearings, and stools, and is one of the chief items of maintenance in the open hearth department.

The electric counterweight, installed on the most recent strippers built by our company, effectively prevent the dropping of the ingot when stickers are encountered and the stripping motion is brought into play to remove the ingot. With the electric counterweight scheme of operation, the hoist controller is of the standard dynamic breaking type and equipped with a standard master controller.

As shown in Figure 1 an auxiliary contact "F" is added to the forward switch in the stripper controller. The stripper controller is a standard straight reversing type except for this auxiliary contact and the stripper master controller is also standard. It will be noted on Figure 2 that a relay "RR" is added to the hoist controller so that the hoist master switch must be in the "off" position to close the "F" auxiliary switch. When the screw motor is energized, as in the case when an ingot is to be stripped, the "H" and "M" switches of the hoist control are closed by means of relay "RR," thus energizing the hoist motor with the total resistance in series. This resistance is calibrated so that the torque produced by the hoist motor balances the weight of the column.

The hoist master controller is capable of operating the hoist motor, either in the hoisting or lowering direction, under all operating conditions and no interlocks are provided to prevent independent operation of the hoist and stripper motions. It is only when the hoist master is in the off position, and the stripper motor energized, that the hoist motor acts as a torque motor and lowers the ingot and mould gently on the ingot buggy.

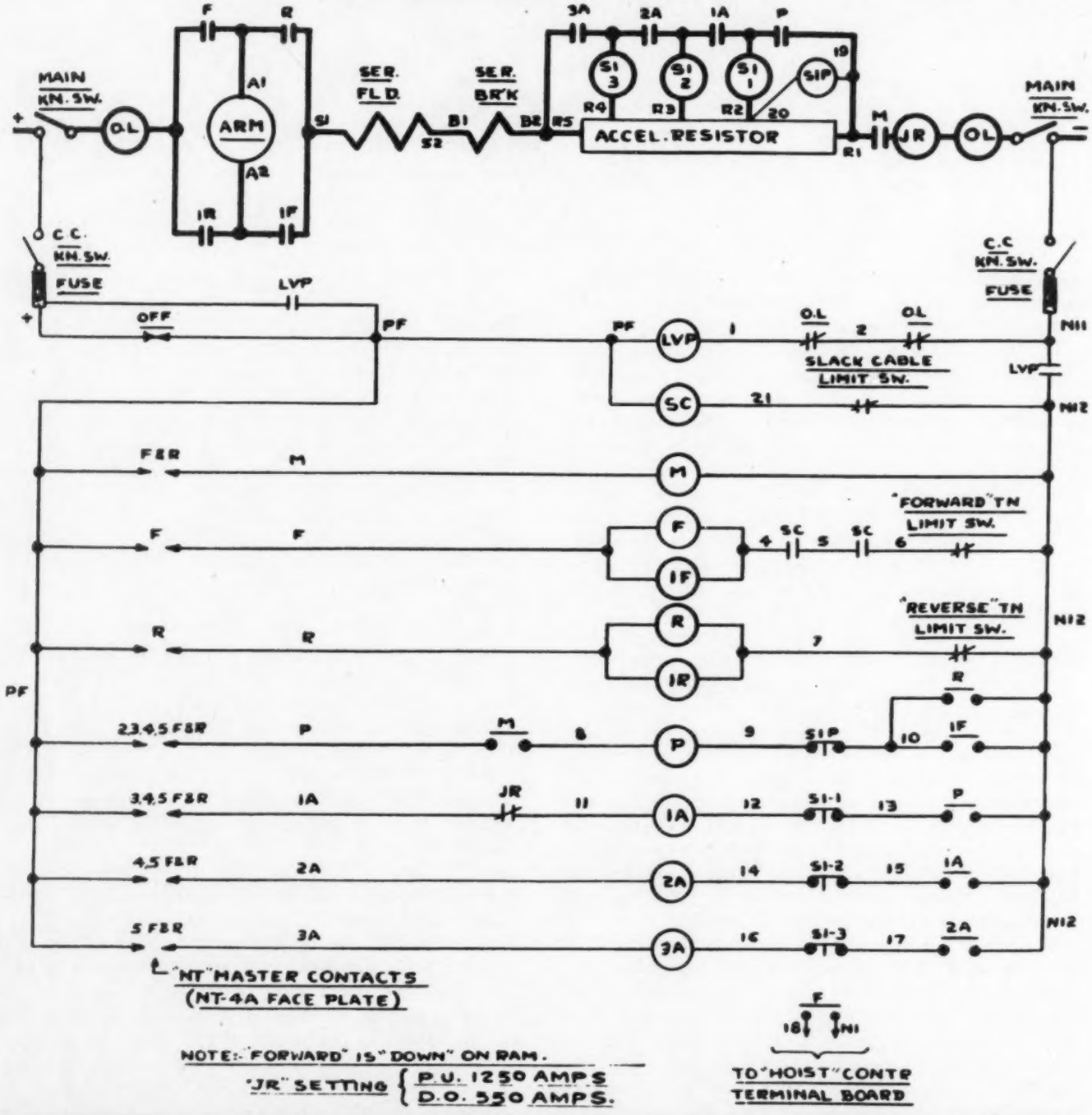
When the screw motor is energized, the hoist motor, under these conditions, is operating exactly as a torque motor. The electric brakes are energized so that any upward force on the column would destroy the balance and cause the armature to rotate in the hoisting direction and prevent slack cable on the hoisting drum. Any weight added to the weight of the column would likewise cause the motor to rotate in the lowering direction. Under these conditions, however, the lowering of the column would not be a free drop as the energized hoist

motor would always be exerting a torque in the hoisting direction which would restrain but not prevent lowering.

Assuming that the stripper is equipped with the electric counterweight, we will go through the stripping operation when a sticker is encountered. The operator will lower his column in the regular way using the hoist motion. He engages the lifting lugs on the mould with the lifting links which are pivotly attached to the column, and then starts to raise his hoist. He finds after he has raised the hoist a short distance, that the ingot is sticking to the mould and as a consequence he has on the hoisting mechanism a load equal to the weight of the column, plus the weight of the mould, plus the weight of the ingot. After he brings the hoist to a standstill, the bottom of the mould may be a foot or more above the stool of the ingot car. He then operates the master controller to rotate the screw and push the ingot out. As soon as he operates this master controller he also energizes the hoist motor, in the hoisting direction, which has enough resistance in series with it to exactly balance the weight of the column.

However, under these conditions just outlined he has the weight of the column, plus the weight of the ingot, plus the weight of the mould, and with this increased load the hoist will start to lower slowly until the mould and ingot are resting on the stool. By this time, the bull nose which is attached to the screw mechanism of the stripper engages the top of the ingot

Figure 1 — Wiring diagram for stripper motion showing the addition of auxiliary contact "F". Motor is 135 hp, 230 v.



and any further movement of the screw will result in pushing the column upward. As soon as the column is pushed upward the hoisting motor which is now energized as a torque motor will rotate the drum in the hoisting direction and prevent any slack cable. In fact, with this scheme of operations the hoisting ropes are always in tension the tension on the ropes being equal to the force necessary to balance the weight of the column.

The electric counterweight utilizes the standard equipment which is furnished with any push-pull stripper, no extra equipment being required except the relays previously mentioned. The thermal capacity of the hoist resistors must be ample for the stripping time.

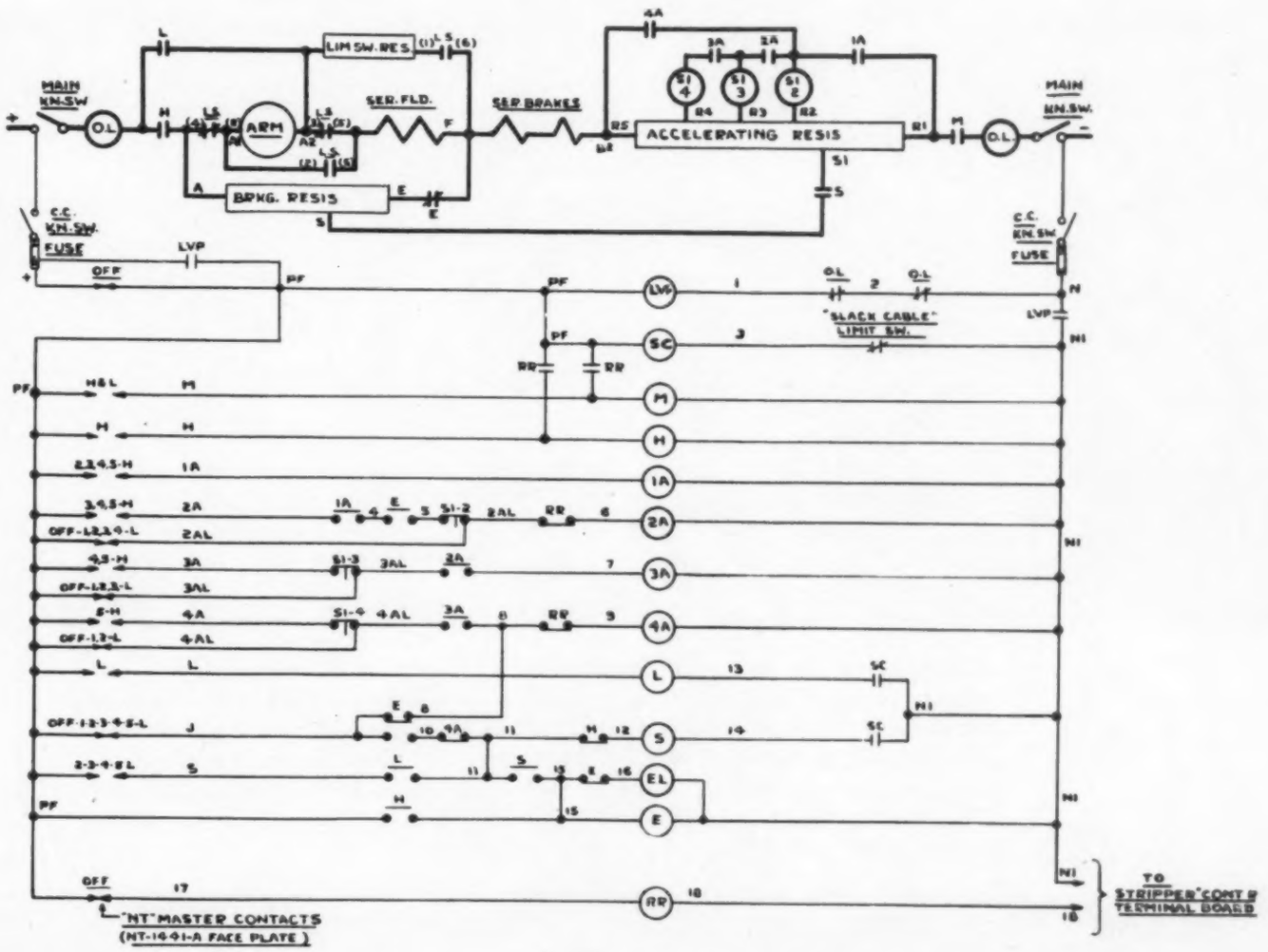
The use of the electric counterweight makes it unnecessary to install the heavy counterweights that have heretofore been used, and also makes it unnecessary to install ratchet gears and auxiliary counterweights which have heretofore been required to prevent slack cable when operating the stripping motion.

Due to friction losses in the hoisting mechanism, the balance between the weight of the column and the hoist motor, with resistance in series, is not critical and as a consequence slight variations in voltage will not affect the sequence of operation.

When stripping ingots with a stripper equipped with the electric counterweight, no added load is imposed on the ingot car as the weight of the column is balanced by the torque of the hoist motor. This statement should be emphasized as many operating men and engineers are of the opinion that when an ingot is stripped with the ingot and mould resting on the ingot car the entire stripping force is imposed on the ingot car. In no case is this true as with a mechanical counterweight the only additional load that can be imposed on the ingot car is the difference between the weight of the column and the counterweight, and with the use of the electric counterweight, no additional weight is imposed on the ingot car as the torque of the hoist motor exactly balances the weight of the column.

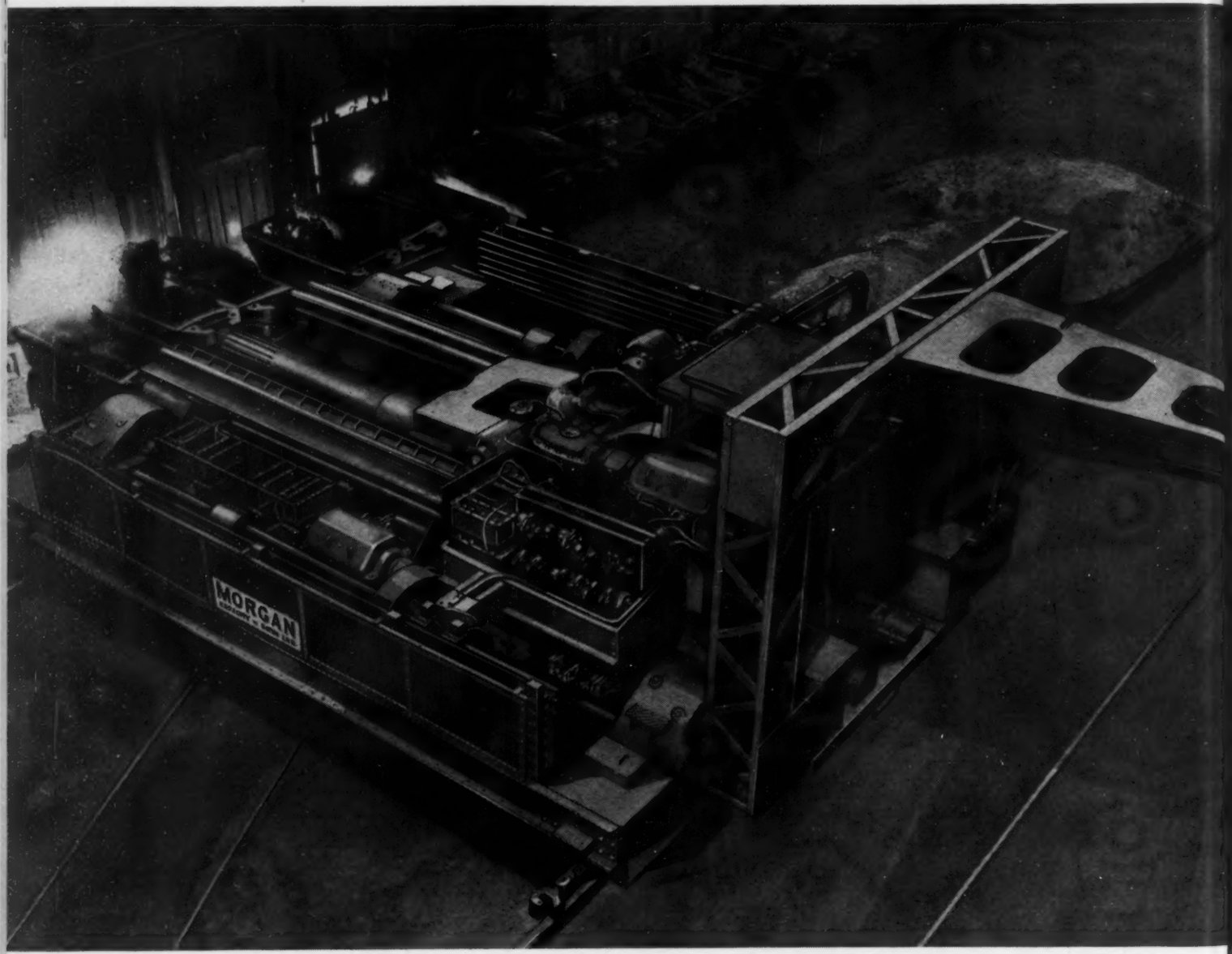
While we have discussed here only the use of the electric counterweight in connection with the operation of stripping cranes, there are many other applications for this ingenious device.

Figure 2 — Circuit of hoist motion is typical except that a relay "RR" is added.



BUILT BY MORGAN Engineering

MORGAN 12-TON LOW TYPE OPEN HEARTH FLOOR CHARGER



Illustrated is one of three Morgan 12-ton 27'-0" span Box Chargers on this open hearth floor. Trolley frame is a one piece steel casting. Girders are of heavy box section. End carriages are of fabricated welded box construction. Roller bearings are used throughout. Entire machine is of massive construction especially designed for taking heavy thrust loads. Morgan Chargers are built in a wide variety of sizes in both the low and high type to meet varied charging floor requirements.

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STEEL INDUSTRY'S EQUIPMENT EXPENDITURES SCHEDULED TO RISE TO $448,000,000 IN 1947

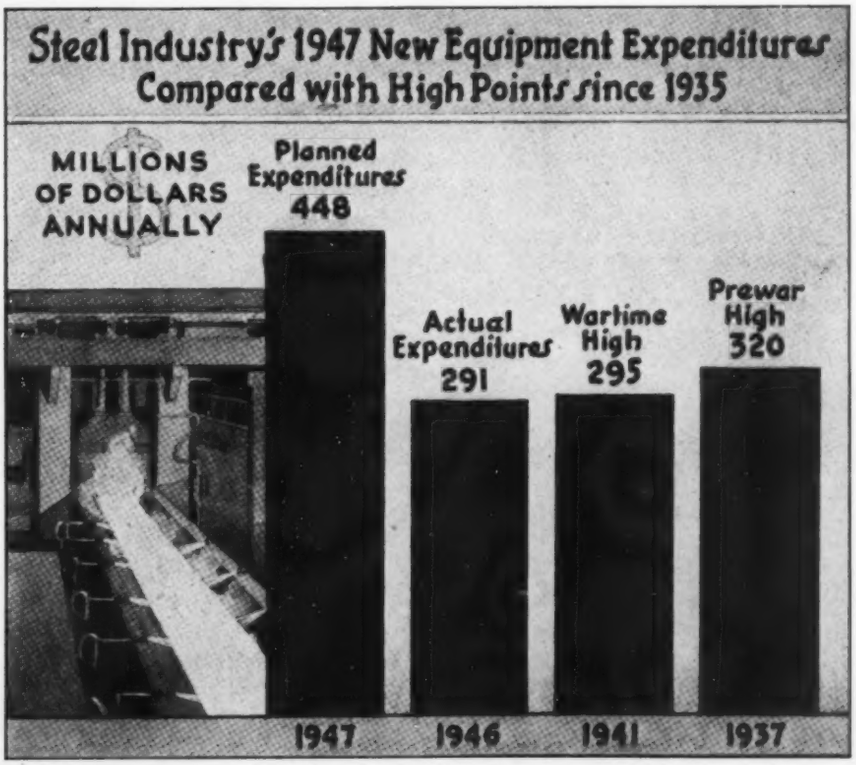
▲ Steel companies plan to spend a record amount, $448,000,000, in 1947 for new equipment and additional facilities required to satisfy current steel demands, according to a survey by the American Iron and Steel Institute. This represents a 54 per cent gain over 1946 expenditures of $291,000,000 out of a total original appropriation of $327,000,000. A portion of the 1947 funds represents a carry-over from 1946, when strikes and shortages of materials delayed the delivery of much equipment which the steel industry had expected to install.

The 1947 appropriation brings to two and three-quarter billions the total amount spent by steel companies over the past twelve years in their programs to expand and improve their plants. From 1936 through 1946 such annual expenditures by the industry have averaged more than $200,000,000 per year.

The expenditures are required to provide the modern equipment, methods and processes for efficient, low-cost manufacture and distribution of products, of a character and quality to meet changing customer requirements. At the same time, much of the new equipment will help increase the output of workers and will improve working conditions and safety. The expenditures in 1947 will cover a wide range of different types of equipment. However, a large portion of the 1947 expenditures will be for expansion of the industry's capacity for sheet and strip steel, products which have been in strong demand for peacetime purposes. This type of steel is required for the making of automobiles, refrigerators, washing machines and other products for householders, as well as for the heavy needs for residential construction.

Other funds will be used in adaptation of facilities built by the government for war purposes and now owned by steel companies for peacetime use. The usual replacement of obsolete equipment and machinery accounts for most of the balance.

This record estimate of expenditures for new equipment does not include the amount, usually estimated at $250,000,000, expended annually for maintenance of existing facilities.



SHEET AND TUBE PAYS BILLION DOLLARS IN WAGES

▲ During the 46-year period from 1900 through December 31, 1946, the Youngstown Sheet and Tube Company had shipped 52,282,178 net tons of steel products and paid its employees $1,173,351,057 in wages and salaries.

This was revealed recently by William H. Texter, assistant sales promotion manager, in a talk at the supervisory management forum of the Economic and Business Foundation. Mr. Texter traced the growth of the company and its influence on the Youngstown district.

The company has paid approximately $200,000,000 in taxes, of

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FORT PITT BRIDGE WORKS

CARNEGIE-ILLINOIS FORGES PARTS FOR CYCLOTRON

A 7000-ton forging press puts the squeeze on a "baby" ingot to shape a pole piece for the University of Rochester's cyclotron magnet. The press is part of the equipment of Homestead works, Carnegie-Illinois Steel Corporation, near Pittsburgh, Pennsylvania. The pole piece ingot weighed 389,000 lb and was one of two identical castings. The steel is of a mild magnetic composition, containing a maximum of 15 points of carbon. This piece is part of a cyclotron magnet weighing 1100 tons, for the second largest cyclotron in the United States. Seldom has it been necessary to assemble so many large forgings for one unit. In addition to the pole pieces, the magnet required four forgings of 157 tons each for the base and top, and two side columns weighing 125 tons each.

which nearly $73,000,000 was in city, county and state levies, and has contributed $3,084,000 to various charitable and community welfare organizations.

The company employs approximately 25,000 persons, has total assets of $230,000,000 has 11,779 shareholders, has an average investment of $8,000 per employee and last year produced 3,242,135 tons of steel ingots.

BRITISH STEEL INDUSTRY TO MODERNIZE IN WALES

▲ A new 50 million pound sterling ($200 million) concern, the Steel Company of Wales, is to be formed to carry out a vast plan for modernization and development of the South Wales sheet and tin plate industry. Leading firms have agreed to cooperate in the erection of a new hot strip plant at Port Talbot and cold reduction mills in Llanelly and Swansea. A third cold mill will be at Newport or Port Talbot. These proposals are described by the companies as the largest in scope and expenditure ever undertaken by the industry. If everything goes well, the new plants, the building of which will provide employment for thousands of workers in what was formerly known as depressed areas, will be in full production in four to four and a half years.

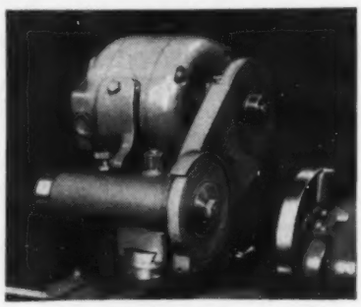
The new company will take over most of the old-type tin plate works owned by Richard Thomas and Baldwins, and Llanelly Associated Tin Plate companies and the sheet works at Newport of John Lysaght Ltd. so that production arrangements can be fully co-ordinated and the problems of obsolescence tackled with a minimum of dislocation and hardship when the new plants come into operation. The Port Talbot and Margam Works owned by Guest, Keen Baldwins Iron and Steel Company Ltd. will also be acquired by the proposed new company and incorporated in the develop-

ment scheme, to form the basis of the hot strip mill.

It is estimated that when the new mills are in full production, the output of the Port Talbot and Margam coke ovens and blast furnaces will be doubled, and the ingot production trebled. The hot strip mill will have an output of 20,000 tons a week.

ELECTRIC GRINDER PERMITS HEAVIER SUSTAINED CUTS

▲ A powerful electric grinding attachment for use on lathes and other machine tools has been developed by the South Bend Lathe Works. Designed primarily for precision external grinding, it is equipped with a 4 in. × ½ in. grinding wheel which is driven by a constant speed continuous duty ¼ hp motor. This permits taking heavier sustained cuts than would be practical with a universal type motor of the same rated horsepower.



Electric grinder mounted on compound rest of lathe.

Available with frame sizes to fit the various sizes of South Bend lathes, this grinding attachment can easily be adapted to other makes of lathes, milling machines, shapers, and planers.

The grinding wheel spindle runs on pre-lubricated sealed precision ball bearings which require no adjustment or additional lubrication. Effectively protected from abrasive grinding wheel dust, the sealed bearings will retain their precision indefinitely. Tension adjustment is provided for the V-belt which connects the motor with the grinding wheel spindle. Both the grinding wheel and the V-belt are enclosed in a single guard.

Spring stops for grinding straight and spiral fluted reamers and cutters, diamond dressers for truing the grinding wheel, and holding fixtures for the dressers can be furnished for use with this grinding attachment. Grinding wheels are available in several grades for grinding various materials including tungsten carbide, tool steel, machine steel, cast iron, brass or bronze, aluminum, Bakelite, hard rubber, and soft rubber. Special cup wheels are supplied for reamer and cutter grinding.

— 3E1 —

BETHLEHEM TO DEVELOP LATIN AMERICAN ORE

▲ The Bethlehem Steel Corporation has allocated $37,500,000 for the development of iron ore properties and facilities, chiefly in Latin America, and expects to tap these new sources for substantial amounts of raw material "some time during 1948," according to the annual report for last year, sent recently to stockholders.

Included in its program are construction of ore storage facilities, trans-shipping stations and river vessels, work on which was delayed due to war conditions. During 1946 the corporation completed and placed in operation three vessels of 24,000-ton capacity taking ore to the United States. Four others are expected to be put in service this year.

Bethlehem had iron ore properties in Coquimbo, Chile; Camaguey and Oriente, Cuba; Michoacan and Guerrero, Mexico, and Bolivar, Venezuela.

The company plans also to spend $125,000,000 for other improvements, additions and acquisitions of properties. It spent $64,431,470 last year for

CUTTER CUTS CORNERS!

A new attachment which makes oxy-acetylene circle-cutting possible to the extreme edge of a plate, and in the corner of any plate, has been developed by the Linde Air Products Company, unit of Union Carbide and Carbon Corporation. This accessory for the Oxweld CM-16 portable shape-cutting machine is known as the under-the-motor circle-cutting attachment. The main advantage of the attachment is that metal can be utilized that would ordinarily have to be scrapped.

The attachment makes it possible for the standard CM-16 cutting machine to cut circles from 2½ in. to 9 in. radius.

— 3E2 —

Do you need more information on any news item appearing in this issue? Complete postal card at right and drop in the mail. We will see that your inquiry receives prompt attention.

Cut evenly along the dotted lines

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I DESIRE MORE INFORMATION IN DETAIL ON THE ITEMS BELOW:

Insert numbers below corresponding to those of the *News Supplement* items in which you are interested in receiving detailed data.

NO.....NO.....NO.....

NO.....NO.....NO.....

NO.....NO.....NO.....

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POSITION.....

COMPANY.....

ADDRESS.....

such purposes. Bethlehem's plant at Sparrows Point, Maryland, is to have new coke ovens, a blast furnace, two open hearth furnaces, and additional tin plate finishing facilities.

WESTINGHOUSE TO OPERATE JOSHUA HENDY PLANT

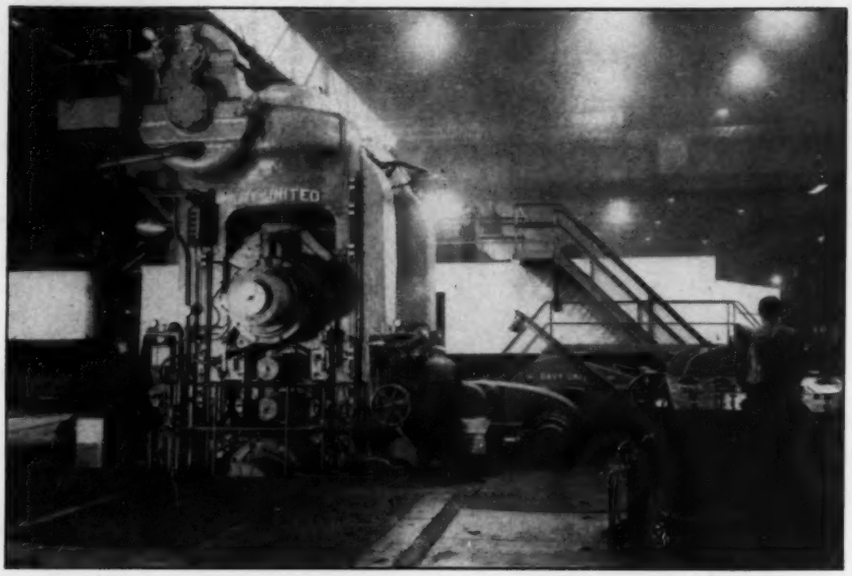
▲ Westinghouse Electric Corporation will take over operation of the Sunnyvale, California, plant of the Joshua Hendy Iron Works under a lease arrangement. Westinghouse is entering into a 10-year lease with option to purchase the California plant.

The 57-acre plant will be operated under the direction of Westinghouse's manufacturing and repair division and will become the largest of 37 manufacturing and repair plants which Westinghouse operates in 25 states, in addition to its principal manufacturing divisions. Other West Coast plants in this Westinghouse division are at Los Angeles, Emeryville, Portland and Seattle.

With its 900,000 square feet of floor space, the Sunnyvale plant becomes a major Westinghouse manufacturing unit. Westinghouse took over actual management of the plant on March 1.

Occupation of the Sunnyvale plant of the Joshua Hendy Iron Works by Westinghouse insures the continuing operation of this plant on a large scale. Hendy will continue as heretofore, concentrating its activities in their southern California plant at Torrance and the Crocker-Wheeler Division at Ampere, New Jersey, neither of which is affected by the Westinghouse transaction.

BRITISH STEEL FIRM INSTALLS NEW 80 IN. COLD MILL



Shown above is the new 80 in. cold reduction, reversing, strip mill, and the first important unit installed since the war, in the British iron and steel industry development program, at John Summers and Sons, Limited, Shotton, Chester, England. The mill is designed to cold reduce hot rolled pickled strip up to a maximum width of 75 inches. It is equipped with tension reels, cone-type uncoiler, and pinch roll feeder on the entry side. Working rolls are 20½ in. diameter, and are backed up by 53 in. diameter alloy cast steel rolls rotating in morgoil bearings.

Mill screws are 18 in. in diameter. The screwdown is operated by two 50 hp motors controlled through a magnetic-clutch coupling. Work rolls are driven through short universal spindles and a pinion stand, by a 2500 hp, 93/106 rpm d-c motor. Two reels are driven by two 500 hp, 200/675 d-c motors in tandem through a 3.86/1 reduction gear. Mill motors are supplied with power from a motor generator set comprising a 3900 hp, 500 rpm, 6600 volt synchronous motor driving a 2200 kw, 600 volt main generator, and two reel booster generators of 456 kw. The main mill control is on the Ward Leonard system.

Coils will be rolled usually in three passes, although five passes may be necessary on the lighter finished gauges. The speed range of the mill is 500-1000 feet per minute. The mechanical parts of the mill were made by Davy and United Engineering Company, Limited, and the main electrical gear by Metropolitan Vickers Electrical Company, Limited.

COAL PULVERIZER FEEDS COAL IN FLUID STREAM

▲ The comprehensive research program now being pushed by the coal industry is supported in many ways by the efforts of fuel users and by the makers of combustion equipment. Engineers throughout industry continue to extract new efficiency from

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Another

IRON AND STEEL ENGINEER

SERVICE!

R-S FURNACE FACTS

ISSUED MONTHLY BY R-S PRODUCTS CORPORATION, PHILADELPHIA 44, PA., FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

R-S FURNACE FAMILY OF SIX

The Lebanon Steel Foundry at Lebanon, Pennsylvania, is the setting for this battery of R-S fuel-fired car hearth furnaces. Two, being on the near side of the transfer pit, do not appear in the pictures. Of the furnaces shown, the two at left (in front view) are direct fired to

operate at temperatures of 1600° to 2000°F. The other two are convection heated for temperatures of 1000° to 1250°F.

Door openings are 7′ wide and 5′ high above the deck of the car. The heating chambers are 13′ 6″ long. Doors, cars, and transfer car are motor-operated from any of four central control stations. One of the control panels is visible between the second and third furnaces facing the combustion chamber for the adjacent convection type furnace.

The view from behind the furnaces shows the circulating fans and ducts for the convection-heated furnaces and the control valves for the high temperature furnaces.

Quench tanks and alloy piers were made and installed by the foundry.

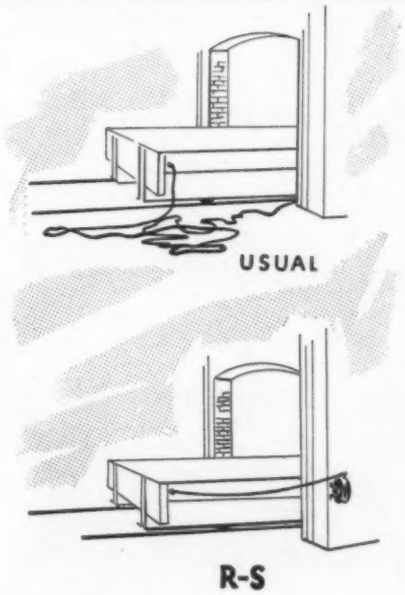
5 Years Without Repairs

Johnnie Huber, in charge of the big R-S rotary furnace at Crucible Steel Company in Harrison, New Jersey, reports that this unit has been operating for 5 years without repairs. It turns out forging billets of a special "tender" alloy, operating at temperatures above 2000°F. Pictured in FURNACE FACTS, Jan., 1947.

Neat Housekeeping around your R-S Car-hearth Furnace

Ever see a car-hearth furnace with an untidy mess of electric cable dragging after it like an overgrown and undisciplined tail? When the car goes in, someone has to gather up the loose cable in a neat pile or coil it on a hook. Meanwhile, it's a hazard; one of the things people trip over!

That, you may be sure, was not an R-S Furnace. We rig the cable on an automatic reel, attached to the car or the wall, as seems most convenient. As the car moves in or out, the reel feeds the cable out or takes it back with neatness and dispatch. Of course, it also eliminates the danger of loose gear on the floor, keeps the cable clean and free of grease, avoids wear and danger of short-circuiting the line, and thus in a small way helps to keep dat ole debbil, Maintenance, down.



From South of the Border

Eric Dolder of R-S Products' Brazilian distributorship was a recent visitor at the factory in Philadelphia.

Senhor Dolder reports that Brazil is "booming." His trip had taken him by plane to Sweden, his birth-place, and other parts of Europe before his final business stop at Philadelphia. From here he and Senhora Dolder were vacationing by slow tramp steamer back to Brazil.

Senhor Dolder is associated in the operation of Equipamentos Industriais EISA Ltds. with Dr. Miguel Siegel, Formerly Chief Metallurgist for the Brazilian National Steel Company. Their main office is at São Paulo; a branch office at Rio de Janeiro.

What does it mean?

An R-S customer, well pleased with the production and maintenance records of his R-S Furnace, hazarded the guess that R-S stands for Really Superb or Really Super.

Old-timers recall that R-S stands for the old Ryan & Scully name which was our label from 1908 to 1931 when the present R-S Products Corporation was formed.

Q. The job that a furnace will do
When it's modern and shiny and new
Is important—that's sure—
But will it endure
Through a decade of service, or two?

A. Our men at R-S have instructions
To emphasize long-life constructions
So your furnace still runs
When it's run by your sons
And *your* woes are all tax deductions!

The Graham Division of the Pittsburgh Screw & Bolt Corporation at Pittsburgh, Pennsylvania, has one of the early R-S oil-fired hardening furnaces which has been pouring out profitable production for 23 years at a cost far below the normal steel mill maintenance cost of 8.2¢ per revenue dollar.

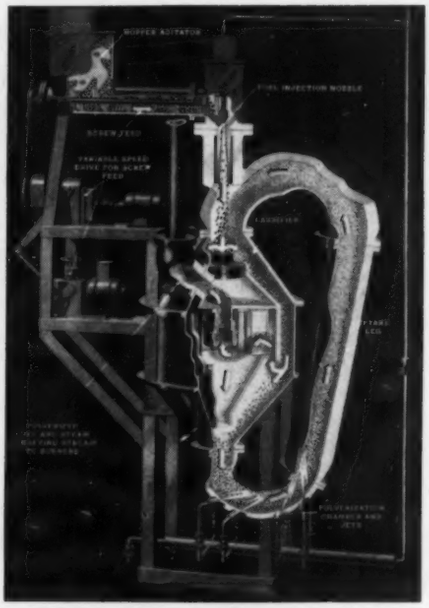
P-C1

coal and to develop equipment that helps to reduce smoke and fly ash.

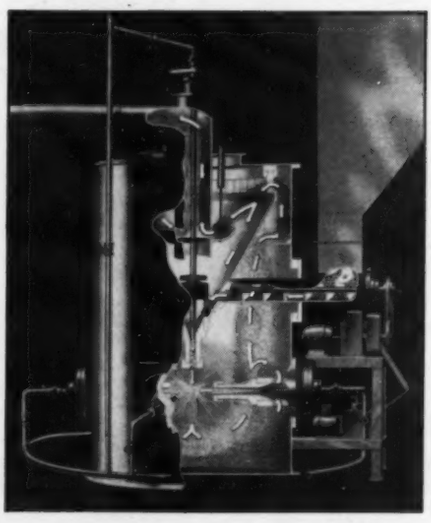
An example of this effort on the equipment front is a new pulverizer developed by Blaw-Knox Company that enables power and steam plants to feed coal to their boiler burners in a fluid stream. Known as the steam jet fuel pulverizer, it is produced in two models, a loop model and a circular type unit. The loop model of the pulverizer was publicly revealed for the first time at the recent power show in New York.

The unusual thing about this device is that it has no moving parts, except for a screw drive that feeds fuel into the unit. Super-heated steam does the pulverizing. The powdered coal is then entrained by steam and delivered to the burners in a fluid stream, much like a gas. This stream-like movement of the fuel provides a high safety factor and permits precise control. Engineers report that the fluid-like coal achieves very complete combustion. As a result formation of smoke is reduced to a negligible quantity and fly ash is confined to mineral and unburnable residue.

A production installation has been in service in a plant at Chillicothe, Ohio, for the past three years. Independent engineers were engaged to check on the results obtained from this unit. On the basis of favorable results reported in this survey and confirmed in the experience with two other units in service at Buffalo, New



Each pulverizer is equipped with a burner for admitting the pulverized fuel into the combustion space of the furnace.



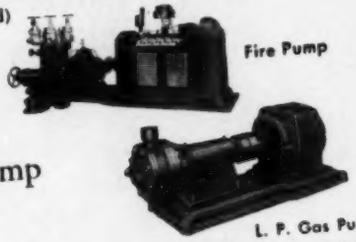
This pulverizer is regarded as especially adaptable to boilers having fluctuating load conditions.

PEERLESS CENTRIFUGAL PUMPS

(Formerly Dayton-Dowd)

PEERLESS PUMPS

Use This Handy Guide to Help You Select the Pump Your Service Requires



PUMP	G.P.M.	DRIVE	HEAD OR PRESS.
TYPE "A"	TO 60,000	ALL FORMS	UP TO 300 FT.

Applications: Designed for general service water pumping in a variety of industries. Embodies most advanced design for efficient, continuous duty applications.

TYPE "B"	TO 1,000	ALL FORMS	UP TO 700 LBS.

Applications: Designed particularly for medium capacity, high pressure boiler feed, oil refinery and pipe line service. Multi-stage, split case construction.

TYPE "AF"	TO 2,000	ALL FORMS	UP TO 125 LBS.

Applications: Peerless Fire Pumps (formerly Dayton-Dowd) are the foremost in fire pumps. Embodying latest developments, their selection assures low cost, modern, plant fire protection. Underwriter's approved.

TYPE "CO"	TO 1,000	ALL FORMS	UP TO 200 LBS.

Applications: Especially developed for chemical, refinery, paper mill, food and process industries. Designed to handle acids, black liquors, hot oil, caustics, etc.

TYPE "TU"	TO 2,500	ALL FORMS	UP TO 600 FT.

Applications: For general water pumping services including oil refinery, boiler feed and mining, where development of heads above the range of conventional single stage pumps is desired.

PEERLESS PUMP DIVISION

Food Machinery Corporation

Factories: Canton 6, Ohio Quincy, Illinois Los Angeles 31, California

District Offices: Canton 2, Ohio; Ardmore, Pa.; Decatur, Ga.; Dallas 1, Texas

Distributors in Principal Cities

York, the company announced the development and scheduled production of the pulverizer.

Tests in the independent survey revealed that the finely divided coal particles from the pulverizer (better than 90 per cent through a 200-mesh screen) produced an average dust loading per cubic foot of flue gas definitely less than the permissible limit prescribed by the smoke ordinances of most large cities. This ability to comply, in most cases, with ordinances covering smoke and fly ash is achieved without the need for special auxiliary equipment for removal of fly ash.

The pulverizer operates on either wet or dry coal; that is, the coal need not be pre-dried. The absence of moving parts, except for the screw feed, reduces maintenance. The units are small in size and due to their vibrationless operation, can be set on ordinary floors without special foundations, nor is bolting to the floor necessary. They are adapted for capacities up to 10,000 pounds of fuel per hour as required.

The steam may be separated from the coal at the burners, or in successive stages before it reaches the burners; or, if desired, it may be sent through the burners into the boilers. The first alternative would be typical practice for most power and steam plants and would permit the use of the residual heat in the steam to preheat the intake air or feed water, or to do other useful work.

An "electric eye", trained on the flame at the boiler burners, insures automatic stoppage of the pulverizer in event of loss of ignition due to any cause.

The Blaw-Knox pulverizer is regarded as especially adaptable to boilers having fluctuating load conditions, and a turndown range of 75 per cent is entirely practical.

— 3E3 —

CROUSE-HINDS REACHES FIFTY-YEAR MARK

▲ On January 18, 1947, the Crouse-Hinds Company celebrated its fiftieth anniversary, and, on such an occasion, a glance at the past is appropriate.

Every business is begun because someone has an idea. In 1896, Huntington B. Crouse had an idea. He wanted to be a businessman.

Heat-beating Deltabeston magnet wire is made in round, square, and rectangular shapes in a wide variety of sizes.

. . . TO HELP YOU
BEAT THE HEAT

Wherever heat is a threat to motor operation, wherever high temperatures call for windings that can "take it," be sure that your motors get the extra protection of Deltabeston* magnet wire. It's real protection for motors that work near installations such as furnaces and strip mills. It's your assurance that motors will withstand severe operating conditions. For your specific needs, there's a Deltabeston magnet wire, built to help your motors beat the heat.

And beating the heat is only part of the heavy-duty job that Deltabeston does. It's built to protect your motors from moisture, corrosive vapors, oil, and other destructive conditions that so often go with high heat.

Whether your motors are rewound in your plant or in an outside repair shop, insist on Deltabeston asbestos- or glass-insulated magnet wire. You'll get more service. less maintenance, and you'll add extra years of life to your motors.

For information on General Electric asbestos, glass, and synthetic wires, write Section Y57-346, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

*Trade-mark Reg. U. S. Pat. Off.

GENERAL ELECTRIC

CENTERLESS BAR TURNER

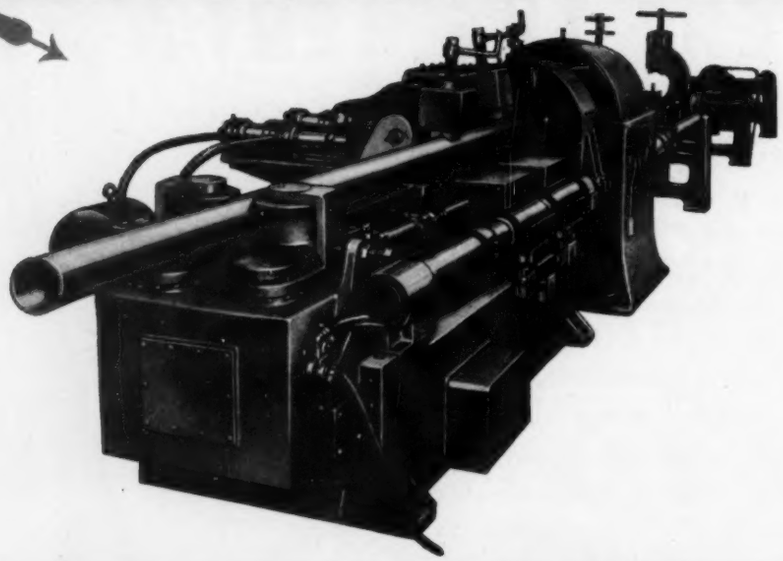
...100% chip recovery

CONTINUOUS • AUTOMATIC • CENTERLESS

BAR & TUBE TURNERS

For speed... and for precision! Continuous, automatic feeding gives you high production unequalled by any other type of turning machine! For both rough peeling and finished precision conditioning, Medart Centerless Bar Turners will turn bars and tubes at maximum rate obtainable from any present day cutting tools. The machines are very flexible. May be used with one or two cutterheads, with one or up to eighteen tools in each head.

"Patents make Jobs"



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY • 3000 DE KALB ST., ST. LOUIS, MO.

Through a mutual friend Mr. Crouse met Jesse L. Hinds, a man over twice his age. Hinds, like Crouse, had an idea. He too wanted to go into business; however, his idea had taken a definite form. He wanted to manufacture articles for the electrical trade.

Both Crouse and Hinds were confident that electricity, which then, in 1896, was becoming a formidable contender with gas for illumination and with line shafts for power transmis-

William Lawyer Hinds, who is now president of Crouse-Hinds Company, was born in 1874. He was elected president in 1943.

sion, was destined to win the struggle.

This conviction formed the basis for subsequent conferences in which both men made discoveries. Crouse discovered that Hinds had no capital but did have the "know how." Hinds discovered that, while Crouse had extremely little capital, he did have boundless enthusiasm. Both discovered they liked each other. So it came about that, on January 18, 1897, partnership papers were signed and the Crouse-Hinds Electric Company was born.

Modest quarters, consisting of one-half the second floor, were rented at 500 East Water Street in Syracuse. The degree of modesty is indicated by the monthly rent, $33.33 including heat and power.

When examining the second floor prior to renting, the partners found one corner partitioned off and occupied by an inventor who was then engaged in preparing to make and sell a patented trolley car headlight. The newly-joined partners thoughtover the

(*Please turn to page 122*)

BOOKLETS

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- Be sure to include your name, address, title, etc., to insure speedy return.

MARCH, 1947

(1) Flexible Couplings

Available to you is a new bulletin which simplifies coupling selection. Bulletin contains detailed illustrations and descriptions of the new and improved Type F Steelflex couplings. Simplified selection tables are included for both motor and turbine applications. (4100). Falk Corporation.

(2) Resin Coating

A booklet is available describing "Nukemite" acid and alkali proof resin coating. Complete details of this product are described as well as its use in pickling and finishing departments. Application processes, general data, and usage information are included. (Nukemite). Nukem Products Corporation.

(3) Air Rectifiers

A folder punched to fit your loose leaf file is available on Lintern Aire Rectifiers telling how they will up crane production. Also included is a description of the use of these rectifiers on soaking pit cranes. Complete data, general information and illustrations of models in use are included. (AC 111546). Lintern Corporation.

(4) Work Masks

A folder is available describing the operation and use of a demand work mask which provides complete respiratory protection for routine or emergency maintenance or repair work in areas made hazardous by toxic gases or oxygen deficiency. (BM-15) Mine Safety Appliances Company.

(5) "Thermit Welding . . . .

. . . for Fabrication and Repair" is the name of a catalog that is available to you. The booklet contains illustrations of how the thermit welding process works. Explains basic difference between this type of welding and other methods. Metal and Thermit Corporation.

(6) Check Valves

A folder is available describing the Williams-Hager silent check valve, the outstanding features of which are: durability, compactness, accessibility and low operating friction. The Williams Gauge Company.

(7) Electronic Controller

A bulletin is available illustrating and describing "Dynalog" electronic recording pyrometers. This bulletin tells how this instrument's continuous balancing action helps the recording pen to traverse the full width of the chart in one second's time. (397). Foxboro Company.

(8) Oil Circuit Breakers

The many features of the Allis-Chalmers FZO-150 Unitop frame-mounted fabricated, three-pole, high voltage oil circuit breaker, in ratings from 15,000 to 46,000 volts are described in a new bulletin available to you. This bulletin includes outline dimensions with weights and oil volumes for reference. (71B6421). Allis-Chalmers Manufacturing Company.

(9) Lubricant Pumps

A bulletin is available describing a complete line of oil and grease pumps for manual, automatic, motor-driven and mechanically-driven operation. Application and installation illustrations and technical data are included in this bulletin. (469). Trabon Engineering Corporation.

(10) Control Systems

Educational bulletin No. 5 on "Automatic Temperature Control Systems" is available to you. Charts, tables and diagrams explain measurement and automatic control and the selection of proper control systems for process applications. (Ed Bull 5). Wheelco Instruments Company.

(11) Turbine Maintenance

Practical information necessary for the proper maintenance of general purpose turbines is contained in a new booklet. The booklet first describes the steam turbine, explains how it operates, and where it should be installed. Directions for piping, joint sealing and lubricating are given. Dismantling of the turbine for complete inspection once a year is recommended, and points to be checked and recorded are listed. (3747). Westinghouse Electric Corporation.

(12) Bearing Metals

A booklet is available describing the making and maintenance of journal bearings, the physical characteristic of Magnolia bearing metals, recommended applications, and isotropic die-cast bronze. Included is a chart giving a list of stock sizes, of standard length 13 in., fully machined bearing bronze. Magnolia Metal Company.

(13) Pyrometers

A catalog is available providing information about a pyrometer which supplements the well-known Micromax line of instruments for those applications which require split-second response to temperature changes, or unusually rapid concentration on a single chart of data from many points. The pyrometer is known as "Speedomax Type G" pyrometer, it is available for use with thermocouples or Rayotubes. (ND46-(1)). Leeds and Northrup Company.

(14) Temperature Control

A booklet is available giving engineering, operating and maintenance data on temperature regulators and controllers. Construction details of each class or type of regulator or controller are shown in detail in cross-sectional illustrations. Included also are sizing and capacity tables

to guide the selection of the proper regulator or controller for specific applications. (464). Leslie Company.

(15) Press Welders

A bulletin is available giving facts on a new air operated press welder. Included are general construction information, data on the various styles available, and operating data. Sectional diagrams and other illustrations show the operation of this new air-operated press welder. (3-113) Taylor-Winfield Corporation.

(16) Aluminum Bus Conductors

A bulletin is available describing the various types of aluminum bus conductors, the current-carrying capacity, joining aluminum bus conductors, and short circuit forces. A reference list of technical articles on this subject appearing in the various engineering journals is included. Fifteen pages oft abular information and charts are included in this 56 page booklet. (AD2A). Aluminum Company of America.

(17) Industrial Greases

A catalog is available giving details on grease for industrial uses. The details include a definition of grease, the purpose of a grease, and grease consistency standards, and the choice of a lubricant. Also included is a section on bearing lubrication. E. F. Houghton and Company.

(18) Diesel-Electric . . . .

. . . . locomotives for industrial switching are thoroughly discussed in five booklets that are available to those interested. The booklets discuss 80-ton, 65-ton, 50-ton, 45-ton, and small diesel-electrics adapted for steel mill switching. All persons concerned with material handling in the steel mill should have these booklets in their files. (GEA3810; GEA3598A, GEA4133A; GEA3666A, and GEA4340). General Electric Company.

(19) Arc Welding

"Alloy Arc Welding Electrodes" is the title of a booklet that is available to you. The booklet covers this company's entire line of alloy electrodes and includes complete technical data on a variety of subjects such as welding procedure, physical properties, metallurgy, and deposit characteristics. All welding supervisory personnel should have this booklet in their files. Alloy Rods Company.

(20) Industrial Pyrometers

Two bulletins are available to you describing a line of pyrometers for general industrial use. One is entitled "Alnor Pyrocon" and the second is entitled "Alnor Pyrometers." These bulletins describe the construction and design of these pyrometers with a description of possible applications. (4361 and 4257). Illinois Testing Laboratories, Inc.

(21) Carbon Products

A catalog is available describing Morganite carbon products such as self-lubricating bearings, bushings, rotary seals, and carbon brushes. This company is one of the largest manufacturers of carbon brushes for electrical machinery. Morganite, Inc.

(22) Electrical Feedrail

Catalogs are available describing an enclosed unit factory assembled electrical distribution system designed for use in connection with the wiring of portable tools, cranes, hoists, and monorail systems, as well as other applications. According to the catalogs the equipment described can be used in a great many applications where movable outlets are required. (Data Bulletin 6 and Catalog 15). Feedrail Corporation.

(23) Induction Motors

A catalog is available describing the Type OG standard squirrel cage induction motor. Descriptions of the constructional features of the motor are included as well as typical applications. (720). Louis Allis Company.

(24) Surface Protection

A catalog is available giving a quick reference list of rust proofing chemicals, protective coatings, metal cleaning chemicals, and inhibitors. This reference list includes descriptions of the various items available to protect the surface of metals. (438). American Chemical Paint Company.

(25) 101 Grinding Questions . .

. . . . are answered in a catalog available to you. This booklet contains actual questions sent to this company and the company's helpful answers to the questions raised. Included with the booklet is a prepaid postal card which will enable you to have your particular question answered by grinding wheel experts. Dayton Grinding Wheel division of Simonds Worden White Company.

(26) Reference Book

The Bantam Bearings division of the Torrington Company announce the availability of a new 168 page manual, No. 15—a combined engineering and application data reference volume for ball radial, ball reciprocating, radial roller, taper roller, and thrust bearings. This book is available only to authorized executives in steel mills. Bantam Bearings division of the Torrington Company.

(27) Liquid Carburizing

A reprinted technical article entitled "Liquid Carburizing" by R. S. Kmarnitsky is available to you. This article covers all phases of liquid carburizing, both the technical aspects and the economics as compared with other types of carburizing. Ajax Electric Company.

(28) Gasoline Engines

A brochure describing a line of 2-cycle series 1200 die cast industrial gasoline engines from 2½ to 4 hp is available to you. Details on standard engines now in mass production are given, as well as information on special engines which the company is prepared to design and mass produce for a wide variety of applications. (1200). McCulloch Motors Corporation.

(29) Control Valves

A bulletin is available describing the new Belfield diaphragm control valve series 700. The bulletin describes the 700 line of diaphragm motor control valves which can be used for a great variety of applications. (500). H. Belfield Company.

(30) Electrical Catalog

A catalog is available to you containing complete information on Thompson disconnecting and lowering lighting hangers, shock absorbers and accessory items. The booklet is in loose leaf permanent binder form and is in two sections at present. Section 1 of 64 pages contains catalog information, and section 2 of 20 pages contains dimension and application diagrams. Thompson Electric Company.

(31) Heat Transmission . . . .

. . . . Through Furnace Walls" is the title of a booklet that is available to you. The booklet contains ten time-saving charts with which engineers and builders of industrial furnaces can easily check heat-flow calculations. In one of the charts, heat loss and outside wall temperature can be read directly when inside temperature, wall thickness and conductivity of refractory are known. The insulating effect of different wall sections can be quickly compared. Lumnite division of Universal Atlas Cement Company.

(32) "Leather Packings . . . .

. . . . for Hydraulic Roll Jacks" is the title of a reprint of an article which appeared in the September 1946 issue of the IRON AND STEEL ENGINEER. This article featured a redesign of the packing on the hydraulic roll balance jacks in a midwestern steel mill which was found to have several advantages and economies. This reprinted technical article is available to you. E. F. Houghton and Company.

(33) Electrofluid Drives

A bulletin is available describing "Why Link-Belt Engineers Created the Electrofluid Drive for You!" The book describes this new drive which is a motorized-hydraulic combination in a "packaged" unit. (2085). Link-Belt Company.

(34) Resistance Welding

A monthly house organ will be sent to you if you encircle number thirty-four. The house organ entitled: "Resistance Welding at Work" is devoted to step by step analyses of interesting problems in resistance welding. Sciaky Brothers, Inc.

(35) Color Conditioning

"Du Pont Color Conditioning for Industry" is available to you. This booklet illustrates and describes years of research and practical experience with color to increase production, improve seeing conditions and create a better working environment. The safety color code for industry is also outlined. A coordinated functional color program for an entire plant is also illustrated. (A-4782). E. I. du Pont de Nemours and Company, Inc.

(36) Lift Trucks

A catalog on hand lift trucks is available, arranged to fit your file cabinet, entitled "Cut Handling Costs with Yale Hand Lift Trucks." The catalog, consisting of 80 pages packed with information on materials handling, will be a valuable addition to a reference library. (S45). Yale and Towne Manufacturing Company.

(37) Graphitar

A catalog is available describing the use of Graphitar in bearings, seals, piston liners, compressor blades, wearing rings, and other parts used in mechanisms where there are conditions of high speed, intense heat or cold, and chemical attack. The catalog tells of the self-lubricating features of Graphitar, (44 pages). U. S. Graphite Company.

(38) Carbon Brushes

A new catalog is available describing Speer Carbon Products. The booklet contains 36 pages on carbon brushes, including information on brush characteristics, brush grades, service recommendations, brush standards, definitions, shunt location data, installation hints, and how to specify brushes. Speer Carbon Company.

(39) Air Filtration

A new booklet on air filtration and dust control equipment, discusses various types of industrial dust problems and typical applications of air filters to such problems. Included in this booklet are a chart of size and characteristics of air-borne solids, sections dealing with atmospheric dust, and information on filtered air for all types of industrial installations. American Air Filter Company.

(40) "Meet United" . . . .

. . . . is a booklet that tells all about United Engineering and Foundry Company, designers and builders of equipment for the metal rolling and forming industries. The book dwells on the facilities available at United to design and manufacture equipment for your plant. Primarily designed as a house organ booklet, it will also serve to acquaint the industry with United. United Engineering and Foundry Company.

(41) Polyphase Motors

A folder is available describing 1 to 350 hp slip ring induction polyphase motors. The booklet tells when slip ring motors are used, gives examples of various requirements, and illustrates with photographs and technical data the various types and sizes of motors in this grouping. (643-6-3) Century Electric Company.

(42) Power Units

A bulletin is available to you thoroughly describing power units from an application standpoint. The booklet tells how these power units are used where extremely high speeds or extreme accuracy of movement are desired, and describes the gears used in these units. (UPA). Foote Brothers Gear and Machine Corporation.

(43) Water Degasification

A bulletin entitled "The Degasification of Water" is available to you. Subjects covered are the removal of ammonia, removal of carbon dioxide, removal of hydrogen sulphide, removal of oxygen and carbon dioxide from process and boiler feed water. (4076). Cochrane Corporation.

(44) Crane Control

Five types of a-c magnetic crane controls for handling any type of load are described in a new booklet available to you. The booklet contains descriptive information, wiring diagrams, performance curves and an application guide to aid in selecting the type of a-c control best suited to any application. (B-3853). Westinghouse Electric Corporation.

(45) Caustic Soda

An elaborate 72 page text designed for use by technical men, buyers and executives interested in the economics of caustic soda, the operations men who are interested in the best procedures for unloading, handling and storing this chemical, the engineer who must design the equipment, and those who desire useful data on the characteristics, uses, forms, transportation, constants, etc., of caustic soda. The book is printed in three colors and contains many useful graphs, charts, diagrams, and descriptive photographs. A valuable addition to steel mill operators' files. (A-100). Columbia Chemical Division, Pittsburgh Plate Glass Company.

(46) Insulating Varnishes

A 40 page booklet containing complete technical and application data on GE insulating varnishes is available to you. The booklet contains specifications, electrical properties, film properties, cure and aging, chemical properties and baking and air drying cycles of each type. Thirty-six grades are described. (CDR13). Chemical Department, General Electric Company.

(47) Bearing Portfolio

A portfolio for shop bulletins on ball bearing practices for the shop man is available to all executives and engineers interested in ball bearing installation and maintenance. The portfolio consists of 27 separate bulletins on all phases of ball bearing practices. Marlin Rockwell Corporation.

(48) Furnace Enclosures

A booklet on furnace enclosures for industry is available to you. The booklet discusses design, assembly, and maintenance of furnace walls, and includes typical installations with appropriate descriptive matter. Diagrams, cutaway views, sectional drawings, and photographs are amply provided. (C-46). George P. Reintjes Company.

(49) Askarel

"Ask for Askarel" is a new bulletin available to you. This booklet reviews the non-inflammable, liquid filled transformers built by this company. Well-illustrated, this booklet contains a summary of the outstanding features incorporated into Askarel transformers. (1246). Pennsylvania Transformer Company.

(50) Combustion Control

A folder is available describing a combustion control system which provides continuous electronic monitoring of oil or gas flame; programming control for automatic ignition systems; and boiler water level control and low level safeguard. A thorough discussion of combustion control is included. (604). Combustion Control Corporation.

(51) Man Coolers

A catalog of portable ventilators and man-cooling fans is available to you. A complete line of industrial ventilators, exhausters and fans is completely illustrated and described. (180). Coppus Engineering Corporation.

(52) Impact Machine

A new bulletin will be sent to you telling about "Cecostamp," an air-operated impact machine on which a wide variety of metal shapes are being made from all of the formable metals. As described in the book, this machine has practically revolutionized the formation of difficult-to-form sheets of stainless steel, aluminum alloy and other metals. (2-L-6) Chambersburg Engineering Company.

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(53) Photoelectric Controls

A folder is available describing a new bulletin introducing a standard line of photoelectric controls, timers, level controls and pilot relays, which have a wide variety of applications in the iron and steel industry. Every operating executive and engineer should have this folder and study the possibility of application in his particular plant. Detailed descriptive literature and specifications are available if the information contained in the folder is not complete enough. (504). Photoswitch, Inc.

(54) Colloidal Graphite

Booklets are yours for the asking, describing 18 good reasons why there need be no clumsy handling of a host of production and maintenance problems. Colloidal graphite can be used for hot conveyor lubrication, drawing die lubrication, improved castings finish, forging die pick-up, and cutting tool life. (460, 421, 422, 423, 431, and 432). Acheson Colloids Corporation.

(55) Rivnut Data

A new edition of the "Rivnut Data Book" has just been published. The book claims Rivnuts are the only one-piece blind fasteners which serve as blind rivets, nut plates for attachment, or both. These fasteners have wide application in many segments of industry. The data book describes construction of each of the regular and special types, lists sizes, dimensions and grip range identifications, details installation methods and tools. (7197-NS). B. F. Goodrich Company.

(56) Bus Structures

Detailed information on isolated phase bus structures is obtainable in a catalog. The many features of this type of bus structure are outlined in the catalog. Added together, these features give you continuous electrical service by eliminating faults and damage and reducing time spent in cleaning, maintenance and repair. (10147). I-T-E Circuit Breaker Company.

(57) Refractories

"Heavy Duty Refractories" is a valuable booklet that will be yours by circling number fifty-seven below. The booklet describes the various refractory materials manufactured by this company. Detailed descriptions are included, with applicational photographs, diagrams, and specification tables. A chart is included which will enable you to select refractories. Every furnace operating executive should have this in his file. (803-9P-11-46). Norton Company.

(58) Meehanite Castings

A new type of news bulletin is being published which contains a series of news items about latest developments in the engineering applications of Meehanite castings in industry. The first issue of this new booklet is yours for the asking. (24). Meehanite Metal Corporation.

(59) Induction Motors

Two recent bulletins on Reliance "Series C" induction motors have been published. Bulletin C-118 covers protected (open type) frame sizes 203 to 326, with horsepower ratings from ½ to 20 horsepower, 600 to 3600 rpm. Construction details, including all-steel frames, welded cores, aluminum pressure-cast rotors, and the new precision bearing mount are described. Totally-enclosed, fan-cooled "Series C" motors are described in Bulletin C-125, which deals with squirrel-cage frame sizes 224 to 326, for two and three phase a-c circuits. (C-118 and C-125). Reliance Electric and Engineering Company.

(60) Spreader Stokers

A new bulletin has been published giving data on approved automatic control layouts for spreader stokers. This four page bulletin illustrates and explains the operation of standardized component parts of the Bailey control system. Also shown are chart records, diagrammatic drawings, and illustrations of an installation. (1022). Bailey Meter Company.

(62) Reproduction Machine

Have you ever wished you could have a copy or several copies of a drawing, book page, a typed page, or photograph without waiting hours for someone to do it mechanically? A booklet is available telling you how to do it in seconds with the new "Ozalid" streamliner. This reproduction machine which is moderately priced will reproduce your typed, drawn, printed, photographic work in 30 seconds. The book tells how to get positive reproductions direct from your originals. These are always dry, ready for immediate use. (Streamliner). Ozalid division of General Aniline and Film Corporation.

(63) Jacklift

Just released is an 8-page booklet on new electric lift trucks called Power Jacklifts. The outstanding features of this truck, according to the booklet, are its 100 per cent electric lift and brake. This truck can be operated with the handle vertical and in every other position and be maneuvered with utmost efficiency in congested areas and in less floor space. (Jacklift). Lewis-Shephard Products, Inc.

(64) Data Record Form

A data record form on flexible couplings has been prepared for distribution. The catalog enables you to receive specific engineering recommendations covering your power transmission needs. No obligation is involved. The booklet is replete with technical data and tables which will enable you in your study of flexible couplings. Lovejoy Flexible Coupling Company.

(65) Chain Belts

Yours for the asking is a new catalog on chain belts for industry. All of this company's standard chains are illustrated and briefly described. In addition, three pages of installation photographs show typical examples of how each style Rex chain is applied. Standard attachments and their use is also discussed. (46-10). Chain Belt Company.

(66) Pour-Rite Ladles

A 48-page catalog on "Pour-Rite" ladles is yours if you encircle number sixty-six. This catalog includes general information, and sections on ladle handlers, gear brackets, trolley shank ladles, hand lever tilt ladles, taper side and cylindrical ladles, crane ladles, and many other types of pouring ladles. Complete specifications with diagrammatic drawings showing operation and installation features are included. Every steel mill operator that uses ladles should have this book in his reference files. (FY-144). Whiting Corporation.

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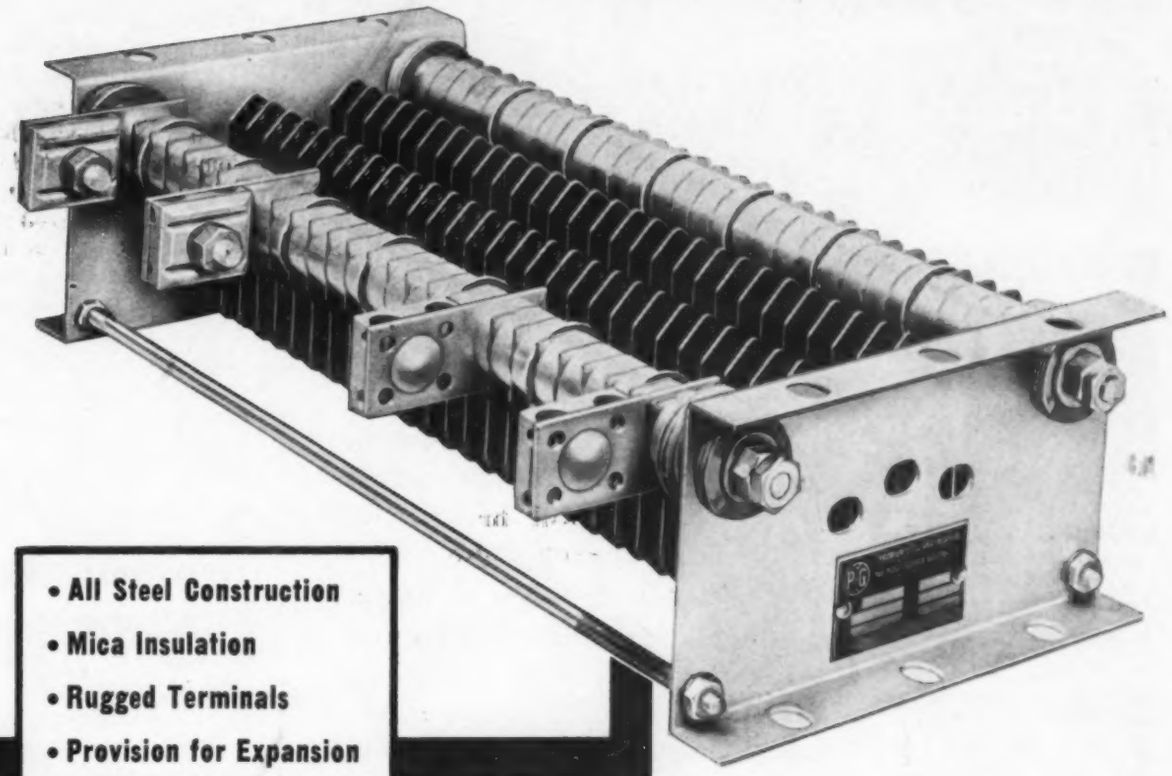

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(*Continued from page 116*)

possibilities and concluded it might be smart to offer to make and sell this headlight on a royalty basis. Such a move would give them another string to their bow. Thus it was that the Syracuse changeable headlight became a Crouse-Hinds product.

By October 1897, the company was gratified to find itself in need of a shipping clerk — one who was ready and willing. A young fellow applied and was hired — he was Charles M. Crofoot, who is today commercial vice-president with headquarters in New York City.

In 1906, there came what looked like an opportunity — once again a man with an idea.

Rigid conduit for housing of electrical conductors had been used for many years and its safety advantages had been well proven. However, its use had been quite generally restricted to concealed work, that is, where the wiring occupied hollow spaces in walls and partitions.

Morton Havens, Jr., an electrical contractor in Albany, had an exposed conduit job to do. He was bothered because he knew he could take no pride in it. Then he had his idea. It was — make a line of conduit fittings designed for exposed work and as well suited to their purposes as plumbing fittings were to their intended purposes.

He designed and had made a few types of fittings. He proposed that Crouse-Hinds Company take on the development of his brain children and their introduction to the electrical market.

At first Mr. Crouse was skeptical. The idea was new. Rigid conduit was run exposed only when it could not be run concealed. The Crouse-Hinds Company had no foundry and no machinery suitable for some of the operations. It looked like placing one's entire bank roll on a horse with no track record. Nevertheless, it was decided it was worth a try.

This new arrival needed a name. After much head scratching and brow wrinkling someone made up the word "Condulet," a contraction of "conduit" and "outlet."

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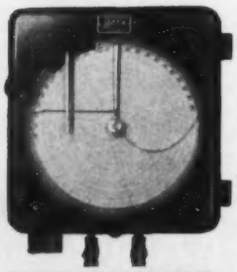

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A 24-hour record of furnace pressure. Shows timing of reversals and each change of pressure made by the operator during the heat.

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Automatically this simple system regulates furnace conditions --relieves operators of many time-consuming details, gives them more time for more important duties. And Hays instrumentation can be complete or partial.

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STEEL FIRM CONVERTING FROM GAS TO OIL FUEL

▲ Allegheny Ludlum Steel Corporation is making a complete survey of its gas-fueled equipment with a view to converting all possible facilities from gas to oil, thereby avoiding future shutdowns caused by gas shortages during cold weather.

The first step of the conversion program already is under way at the corporation's West Leechburg, Pennsylvania, plant where the slab reheating furnaces are being changed over from gas to oil, permitting operation of the hot mills without regard to weather conditions. That changeover, affecting a minimum of 800 employees, will be completed early next week.

Cold weather and resultant shortages of natural gas supplies have caused curtailment of production at the corporation's West Leechburg and Brackenridge plants, totaling, in the case of some departments, as much as four weeks since the first of the year. At times as many as 6000 employees have been affected with all

production stopped at West Leechburg and all gas-fueled operations closed at Brackenridge.

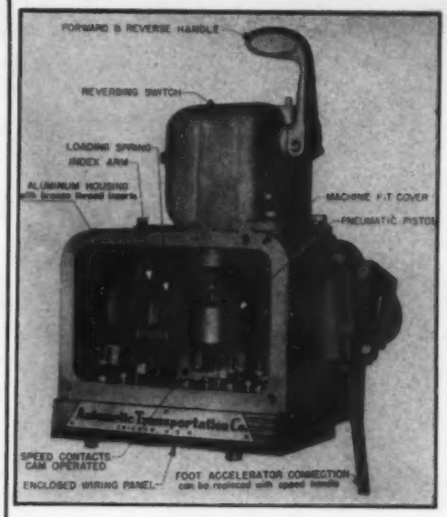
Officials of the corporation hope that sufficient regular and emergency facilities can be installed by next winter to allow full production at both mills during gas crises.

BABCOCK-WILCOX REVAMPS BARBERTON, OHIO, PLANT

▲ Announcement of a two-year, $1,500,000 program for machinery replacement and improvement of its Barberton, Ohio, plant was made by the Babcock and Wilcox Company recently. The money for this project, which will include all shops, has already been allocated. In addition to the new equipment to be installed, production will be facilitated by the relocation of machinery and rearrangement of certain shops in order to minimize the handling both of raw materials and the products manufactured.

The improvement plan will proceed without interrupting production. To date about one-half of the funds allotted have been spent. The program was drawn up by the company's staff engineering department in consultation with the heads of shops and executives.

The modernization program serves a two-fold purpose in that it will replace worn out machines as well as allow for the installation of equipment adaptable to the most modern metal cutting methods known. The introduction of new manufacturing methods and the changing manufacturing requirements necessitate constant re-analysis of plant requirements.



AUTOMATIC GEARSHIFT HAS ECONOMY IN OPERATION

This is the "pneumatic brain" which has revolutionized the electrical system of Automatic Transportation Company's 1947-model industrial trucks and brought new ease and economy of operation to the material handling field. Known as the Newmatic controller, it operates as the electrical counterpart of the automobile automatic gearshift.

Heart of the Newmatic is the pneumatic cylinder and spring-loaded piston. The spring is extended as the accelerator is applied, the spring drawing the piston downward. Air enters the cylinder through a jet, allowing the piston to move at a constant and pre-set speed. The downward movement of the piston operates the speed contacts in order. 3E4

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Personnel News . . . .

Admiral Ben Moreell, for the past several months president and director of Turner Construction Company, New York, has been elected board chairman, chairman of the executive committee and president of Jones and Laughlin Steel Corporation, Pittsburgh. He succeeds **H. E. Lewis,** retiring because of ill health, but who continues as a director and member of the executive committee.

Admiral Moreell had been federal coal mine administrator. During the war he organized and headed the Navy's Seabees and expedited the construction of aviation gasoline plants. As a result of his outstanding war service, he was awarded meritorious honors by our government, Great Britain and the Republic of Haiti.

In 1945 he was in charge of strike-bound oil refineries and pipelines which had been seized by the Navy, and last year was in charge of operating the nation's coal mines during the period of strikes and governmet control.

Admiral Moreell started active duties with Jones and Laughlin on March 17. He will, however, continue as president of Turner Construction Company until June 1 and he will continue a director of that company after that date.

William D. Taylor, who has been engineer of tests for Lukens Steel Company, has been appointed assistant metallurgical engineer, and **Samuel D. Lemmon,** who has been assistant engineer of tests, has been appointed engineer of tests.

Mr. Taylor entered the employ of Lukens as an apprentice metallurgist following his graduation from Swarthmore College in 1936 with a bachelor of science degree in mechanical engineering.

Mr. Lemmon came with Lukens in 1939, shortly after graduating from Pennsylvania State College with a bachelor of science degree in chemical engineering. He worked as an observer in the research department and became a metallurgical investigator in 1940. He was appointed research metallurgist in 1943 and assistant engineer of tests in 1944.

Samuel L. Moffatt has been appointed superintendent of the open hearth department, Portsmouth Steel Corporation, Portsmouth, Ohio.

John G. Rohrman was appointed assistant superintendent, production planning department, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Rohrman is a mechanical engineering graduate of the University of Pittsburgh. He had previously been employed in various capacities at the Duquesne works.

Harry W. Finney was appointed assistant to superintendent, blast furnace department at Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Finney was graduated from Pennsylvania State College with a bachelor of science degree in mechanical engineering. Previous to his present appointment, Mr. Finney served as a special engineer in the blast furnace department at Duquesne works. He served as an ensign in the United States Navy during World War II. Prior to his naval service, he had been employed at the Duquesne works.

Howard W. Kane was elected president of Kane and Roach, Inc., Syracuse, New York, succeeding his father, the late **William E. Kane.**

George B. McMeans has been appointed assistant general superintendent of the Fontana, California steel plant of Kaiser Company, Inc. Mr. McMeans was formerly manufacturing manager of the open hearth and hot mills for John A. Roebling's Sons Company.

Harry W. Carson has been appointed manager of the mechanical department of the Dunkirk, New York plant of the Allegheny-Ludlum Steel Corporation, succeeding **Herbert R. Rose,** retired. **Patsy L. Scott** has been named night superintendent to succeed **John F. Baer,** retired.

Hans Gartmann has been appointed chief engineer of the centrifugal pump and compressor department of the De Laval Steam Turbine Company, Trenton, New Jersey. Mr. Gartmann has been associated with De Laval since 1924, first as a designer of centrifugal pumps and compressors and later as a hydraulic engineer.

Harry Engvall has recently been appointed chief engineer of the helical gear department of the De Laval Steam Turbine Company, Trenton, New Jersey, with whom he has been associated for 23 years.

H. E. Beane has been appointed general sales manager of the Bristol Company, Waterbury, Connecticut. Starting as a sales engineer, Mr. Beane has been associated with the Bristol Company since 1920. From 1925 to 1935, he was district manager of various branch offices of the company. He became field sales manager in 1936, and sales manager in 1943.

WILLIAM D. TAYLOR

SAMUEL D. LEMMON

JOHN G. ROHRMAN

HARRY W. FINNEY

C. W. Conn has resigned his position as assistant open hearth superintendent, Kaiser Company, Inc., iron and steel division, Fontana, California, to assume the position of superintendent of open hearth for the Ford Motor Company, River Rouge, Michigan.

Harold V. Rasmussen has been appointed chief engineer of the turbine department of the De Laval Steam Turbine Company, Trenton, New Jersey. Mr. Rasmussen has been associated with De Laval since 1941. Before coming to De Laval, Mr. Rasmussen was

HAROLD V. RASMUSSEN

connected with the Westinghouse Electric Corporation from 1922-1941, first as a design engineer on industrial and central stations and marine turbines and later as manager of development of land and marine turbines.

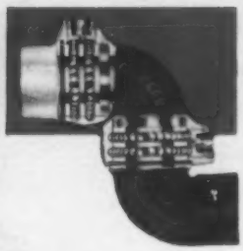
E. A. Hurme was appointed central district manager for the Sperry Corporation, with offices at 2400 West Madison Street, Chicago, 12, Illinois. Mr. Hurme formerly served as district manager for the Crocker Wheeler division of the Joshua Hendy Iron Works.

Edward A. Linhart was appointed director of industrial relations for the Follansbee Steel Corporation.

EDWARD A. LINHART

Mr. Linhart will be responsible for the administration of wholesome industrial relations policies in the various plants and divisions of the Corporation. He is a graduate of the University of Pittsburgh and had previously been in industrial relations work with the Aluminum

CHIKSAN



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CHIKSAN COMPANY BREA CALIFORNIA

Company of America at its Edgewater, New Jersey, plant, and later with the Elastic Stop Nut Corporation of America, at Lincoln, Nebraska.

Don L. Orton, for many years contacting the steel industry in the Chicago-Gary area for the Clark Controller Company and more recently general sales man-

DON L. ORTON

ager, has been elected vice-president of the company. He will continue also as general sales manager.

E. A. Damrau was appointed district manager at Charleston, West Virginia, for the Okonite Company. **Walter E. Garrigan,** who formerly assisted Mr. Damrau in the Pittsburgh district, is now Pittsburgh district manager for the same company.

J. J. Mellon was appointed chief engineer of the Allen Bradley Company at Milwaukee, Wisconsin. Mr.

J. J. (ANDY) MELLON

Mellon was previously associated with Clark Controller Company.

Carl F. Hayden was elected president of Hayden and Company, Chicago, Illinois. This firm is exclusive sales representative for the General Regulator Corporation in the middle west territory.

C. J. Moore, assistant manager of the Pittsburgh branch of the Electric Storage Battery Company, has been promoted to manager. Mr. Moore entered the employ of the company in December 1935, as a salesman in the Pittsburgh branch.

Obituaries

J. Leo Scanlon died January 30, 1947. Mr. Scanlon was general manager of the J. Leo Scanlon Company located in Buffalo, New York. He had been a member of the AISE since 1920.

Henry E. Meyer, general master mechanic, Great Lakes Steel Corporation died recently. Mr. Meyer had been a member of the Association of Iron and Steel Engineers.

James M. Bray, 50, chief roll designer for the United Engineering and Foundry Company, died February 12, 1947. Mr. Bray was an employee of the company for 38 of the 40 years he resided in Pittsburgh. He was a member of the Engineers Society of Western Pennsylvania and the Association of Iron and Steel Engineers.

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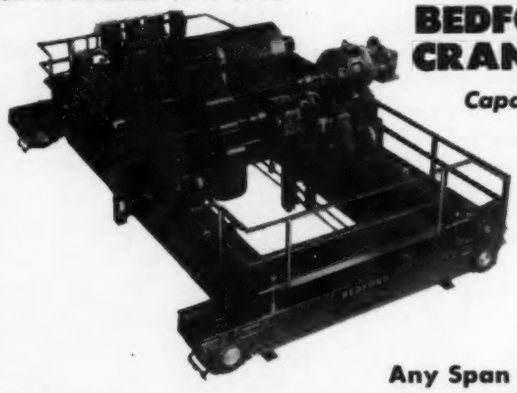

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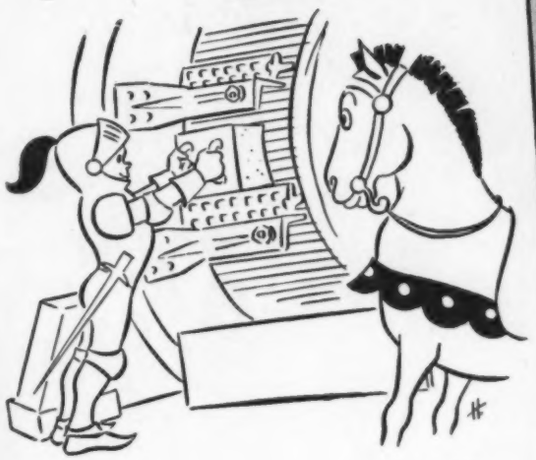

No brush can perform properly on a poor commutator. Therefore, before installing new brushes, check this part of your machine. If it is grooved, out of round, has high or low bars, grinding or turning may be advisable. Also, inspect undercutting for protruding fin mica or high spots that cause excessive sparking, chattering, commutator burning and flatting. Assuming proper commutator condition, a set of MORGANITE brushes — proper grade; properly installed — can give you the finest commutation possible.

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TRADE MARK CARBON BRUSHES

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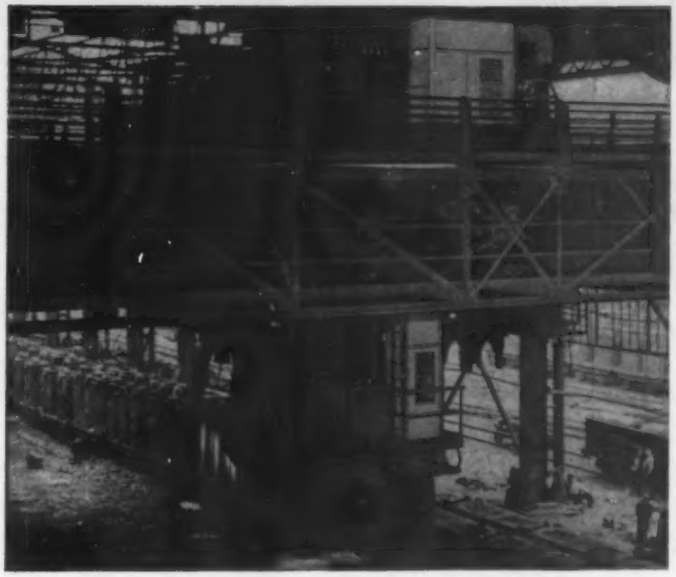

Soaking Pit Crane in plant of a prominent steel company, equipped with Lintern Aire-Rectifier 145 AC-24.

Soaking Pit Crane Cabs Successfully Air Conditioned with Lintern Aire-Rectifiers

● "Air condition a soaking pit crane cab and you can air condition any of 'em," said the mill superintendent. We did it.

And we have done it with units which have demonstrated over the months and years their *low maintenance*. In a large number of plants Lintern Aire-Rectifiers, *with air-cooled condensers*, have performed successfully under the most severe conditions.

Lintern *balanced refrigeration design* prevents overloads in temperature as high as 170° F. This is the only crane cab conditioner which has had thorough testing on soaking pit applications. *It is tried and proved.* Only periodic inspection is required.

Ask for Bulletin AC 11546.

THE LINTERN CORPORATION
54 LINCOLN AVENUE - BEREA, OHIO
Glowlite Signals, Lanterns, Sanders, Shock Absorbers for Lamps, Ventilating Heaters, Aire-Rectifiers for Overhead Cranes.

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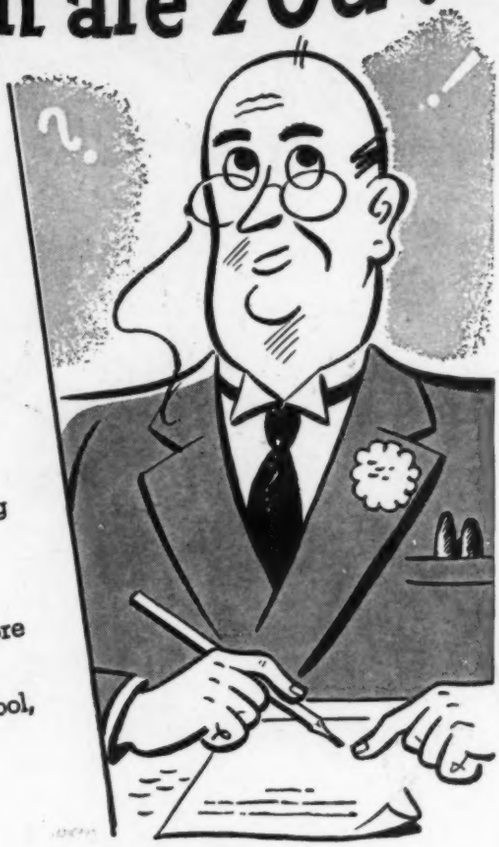
How Good a Salesman are YOU?

TEST YOURSELF WITH THIS PRODUCT—

Guaranteed to Please Every Customer



CHECK HERE
how many of your employees are buying U.S. Savings Bonds regularly

HERE'S HOW YOU RATE
according to national averages

- ☐ **90%** or more ➡ No one needs to tell you anything about selling.
- ☐ **80%** or more ➡ Excellent.
- ☐ **70%** or more ➡ Not bad. Just apply a little more effort.
- ☐ **60%** or less ➡ This wasn't a high mark in school, either.

The "PRODUCT"—U. S. Savings Bonds—is easy to sell, because it offers every prospect a guaranteed means of making money. Each unit can produce $4 for every $3 of purchase price.

The MARKET consists of all your employees. It is an eager market, as shown by surveys—which indicate that 85% of all participants in the Payroll Savings Plan want the plan continued.

The REWARD is twofold: By helping your employees build personal security, you help assure that they will be happier, more stable—more productive on the job. And you help *all* of us, including yourself, because every Bond you sell helps to check inflationary tendencies.

Are You Using These Booklets?

If not, or if you wish additional copies, just ask your State Director of the Treasury Department Savings Bonds Division.

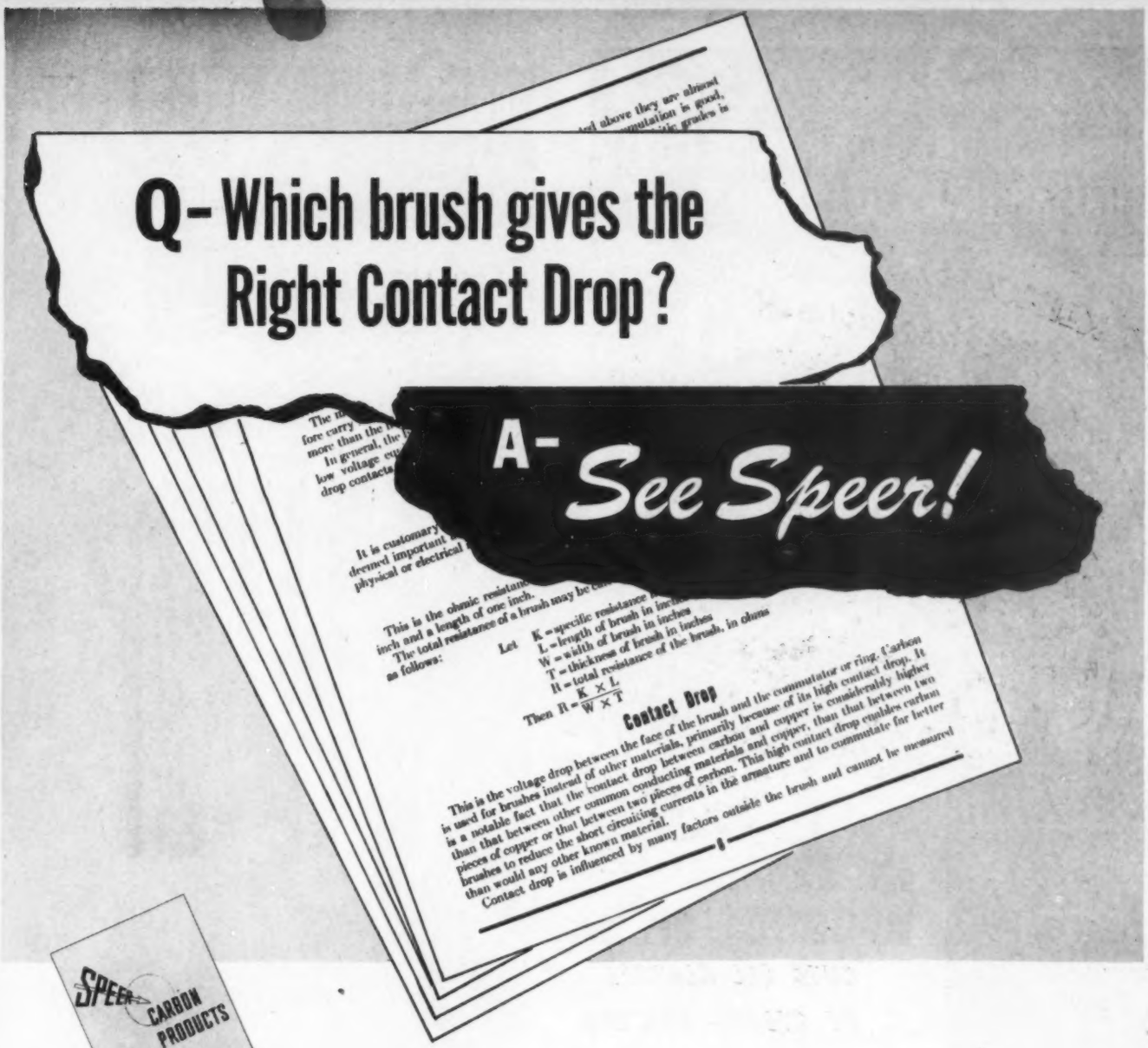
THE PEACETIME PAYROLL SAVINGS PLAN—A booklet, published for key executives by the Treasury Department, containing helpful suggestions on the conduct of your payroll savings plan for U.S. Savings Bonds.

THIS TIME IT'S FOR *YOU*—A booklet for employees . . . explaining graphically how the payroll savings plan works . . . goals to save for, and how to reach them with Savings Bonds.

The Treasury Department acknowledges with appreciation the publication of this message by

IRON AND STEEL ENGINEER

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council



MORE ANSWERS IN THIS BOOK. GET IT!

This catalog *SPEER CARBON PRODUCTS* gives detailed information on brush characteristics, includes Speer Brush Data Sheets. It answers your questions on brush selection, helps you find the right brush for your motors or generators.

A brush with the *right contact drop* reduces short circuiting currents in the armature. A brush with the *right contact drop* increases commutating efficiency, gets the most out of your commutating equipment!

There is a Speer brush with the right contact drop for your particular operating conditions. There is a Speer brush with the right combination of *all* the vital characteristics for your specific requirements. That's why Speer Brushes bring increased efficiency wherever they are installed!

Speer

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If You Want to Slash METAL CUTTING & TRIMMING COSTS FROM DOLLARS TO PENNIES

Read this

KLING *Friction Saws Cut All these Bars and Shapes in a few Seconds*

24" 100# I-BEAM 28 SECONDS

15" 55# CHANNEL 15 SECONDS

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9 SECONDS 100# A.R.A. RAIL

5 SECONDS 6½"x6½"x19.8# TEE

11 SECONDS 8"x8"x¾" ANGLE

10 SECONDS 3" SQUARE

15 SECONDS 4" ROUND

11 SECONDS 6" O.D. TUBE ½" WALL

NO CHANGE OF BLADE OR SET-UP NECESSARY

INCREASES PRODUCTION...

CUTS ALL CLASSES OF STEEL - QUICKLY AND ECONOMICALLY

The versatile ability of the Kling Friction Saw to cut varied structural shapes in any sequence, without change of blade or set-up, permits one machine to handle various types of work which, otherwise, would require several slow speed saws to handle.

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GET COMPLETE INFORMATION

CONSULT KLING ENGINEERS REGARDING YOUR CUTTING PROBLEMS. WRITE FOR BULLETIN No. 9200 GIVING VALUABLE INFORMATION. SENT WITHOUT COST OR OBLIGATION.

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Production goes UP — overhead costs go DOWN — when Ohio "Extra Strength" Magnets are on the job. Wherever ferrous metals must be handled in quantity, these rugged, dependable lifting magnets are giving EFFICIENCY and PROFITS a lift. Ohio "Extra Strength" Magnets move iron and steel in any form . . . faster . . . safer . . . and cheaper . . . than any other method.

Why cling to dangerous, inefficient and time-consuming methods when Ohio Magnets handle ferrous metals so much better? Investigate the tremendous savings provided by these magnets — today! Ohio Electric Mfg. Co. engineers are always ready to assist you in the solution of your problems.

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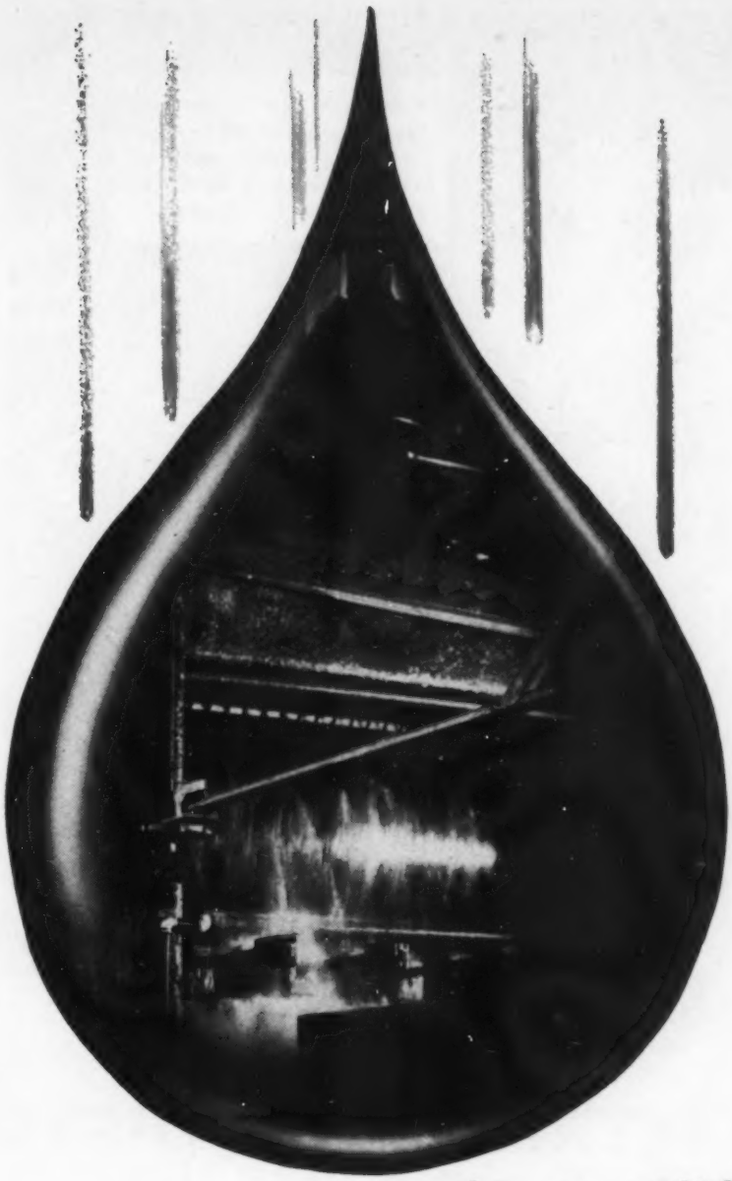

MILL BEARING COSTS DROP

—when you switch to N·B·M #200 Bronze

From Harrisburg to Gary, Plate and Blooming mills report substantial savings in replacement and maintenance wherever N-B-M #200 Bronze Bearings shoulder the load.

Example: 134" Plate Mill—pump lubrication. Previous bearings averaged 25,000 tons rolled. A single set of N-B-M #200 Bronze Bearings have rolled 190,000 tons.

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Blast Furnace Copper Castings • Roll Neck Bearings
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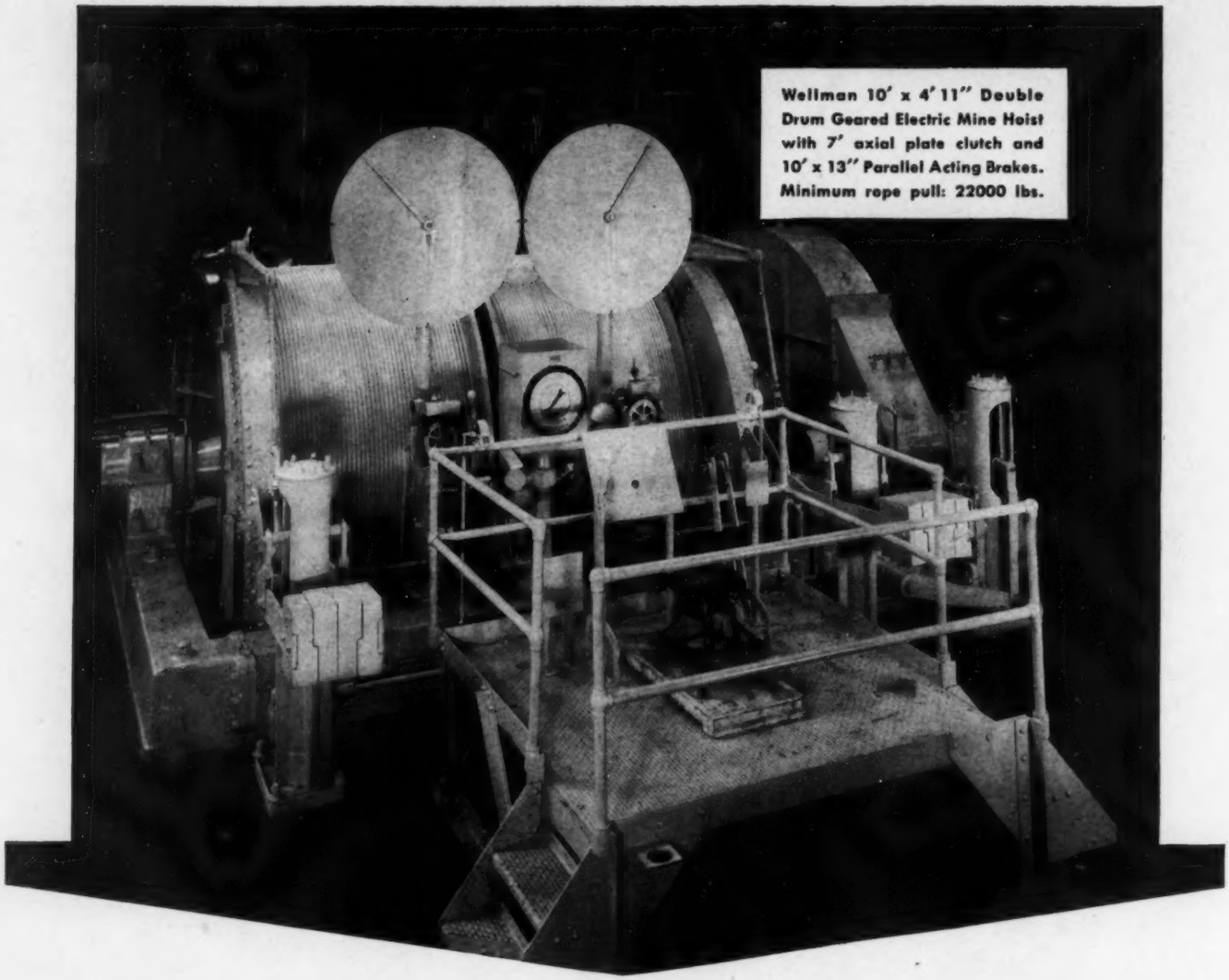
Wellman 10′ x 4′ 11″ Double Drum Geared Electric Mine Hoist with 7′ axial plate clutch and 10′ x 13″ Parallel Acting Brakes. Minimum rope pull: 22000 lbs.

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Designed by Specialists • Built by Specialists

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Ore and Coal Handling Bridges
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WELLMAN Electric Mine Hoists are used in mines all over the world. Backed by half a century of diversified experience, they incorporate the best and latest principles of design and construction and provide maximum safety with economical, trouble-free operation.

Wellman hoists have been built in a wide range of sizes to operate under a wide variety of conditions. Ask us for recommendations on your job!

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The use of De Laval double reduction worm gears for operating the screw-downs on this Farrel-Birmingham sheet rubber calender illustrates the extreme compactness of this type of drive for transmitting high torques at high reduction ratios. Each screw-down is adjusted by means of a separate motor and reducer unit, making it possible either to adjust each end of each roll independently or to synchronize the adjustment of both ends in parallel.

1153

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CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

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CRANE CAB COOLER

by DRAVO

Assures Comfortable Working Conditions

It's been Job-Tested

Completely self-contained ***Dravo Crane Cab Cooler.***

Typical arrangement of ***Dravo Crane Cab Cooler*** *on Soaking Pit Crane.*

Provides:

Cooling — Dehumidifying — Dust Filtering — Fume and Odor Removal — Continuous Ventilation — Winter Heating

Here are the outstanding characteristics of
DRAVO CRANE CAB COOLERS:

- Self-contained unit requires *electrical connection only.*
- Air-cooled condensers *completely eliminate* water requirements.
- Mill-type construction of electrical and mechanical equipment.
- Forced ventilation of motor and dust-tight control cabinet.
- Simplicity of installation and maintenance; accessibility for servicing.
- Proved by successful application in the hot spots.

Bulletin CC-515 describes the construction and application of ***Dravo Crane Cab Coolers.***

DRAVO CORPORATION

PITTSBURGH, PHILADELPHIA, CLEVELAND, NEW YORK, DETROIT, WASHINGTON, WILMINGTON

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Don't Lubricate until 1952

The generator with the built-in regulating circuit that automatically holds steady voltage.

Says

Electric Machinery Mfg. Co. of Minneapolis, Minn., another user of Norma-Hoffmann's Patented "Cartridge" Bearings

The new "Regulectric" generators need no adjustments, no maintenance, no attention for years and one reason is—

. . . the bearings are sealed as effectively as are the components of the built-in regulating circuit.

Made to double-row width, these "Cartridge" Bearings have 100% more grease capacity than any other standard self-sealed type and they also permit added shaft strength and reduced overhang. Write for all the facts on Norma-Hoffmann's "Cartridge" Bearings.

NORMA-HOFFMANN
***Precision* BEARINGS**
BALL • ROLLER • THRUST

NORMA-HOFFMANN BEARINGS CORPORATION
STAMFORD, CONNECTICUT
FIELD OFFICES: New York, Chicago, Cleveland, Detroit, Pittsburgh, Cincinnati, Los Angeles, San Francisco, Seattle, Phoenix

Not a minute lost in 9 years

for lack of lubrication

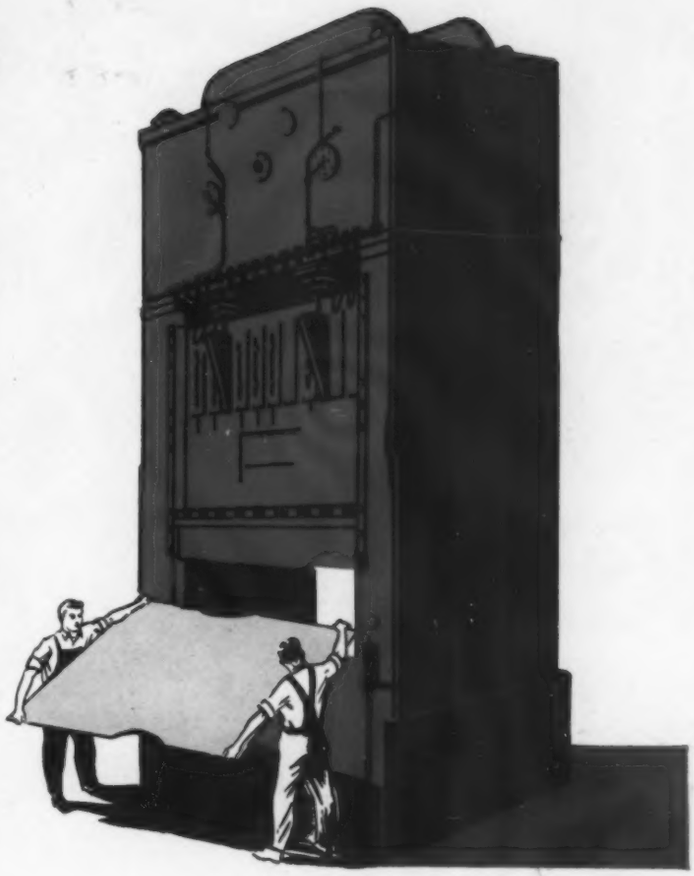
BACK in 1937 a large Detroit metal fabricating plant installed Farval centralized lubricating systems on its metal-forming presses—a total of 133 systems, serving 3100 bearings.

In the 9 years since then, no machine has been down to lubricate or to repair the lack of lubrication. Farval saved the labor cost of 11 oilers per 24-hour day. Even more important during the war and postwar years has been the elimination of delays to production, such as were caused in the old days by stops for oiling, stops for repairs, stops for bearing replacements. Farval has paid for itself many times over.

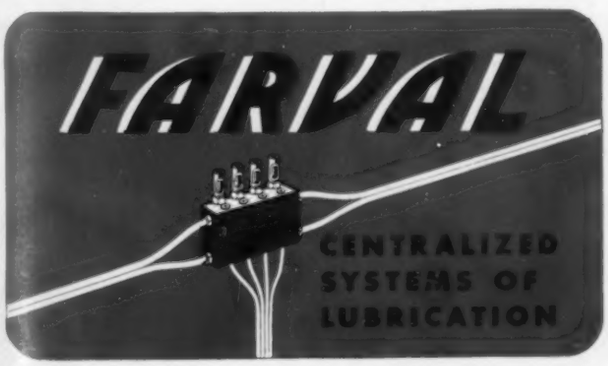
Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. Farval—the Dualine System with the Positive Piston Displacement Valve—that has but 2 Moving Parts—is Fully Adjustable—and with a Tell-tale indicator at each bearing to show the job is done.

Savings comparable to the above can be made on your equipment with Farval. Write for Bulletin 25. The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



FARVAL—*Studies in Centralized Lubrication No. 85*



Selection of factory-assembled Limitamp control for this plant made it possible to install a single compact group, instead of a number of separate devices, in a small amount of floor space.

Here's FAST, "PACKAGED" Short-circuit Protection for Your High-voltage Motors... Limitamp Control

LIMITAMP CONTROL

OPERATES WITHIN A SPLIT CYCLE

● You can give your motors sure short-circuit protection by specifying G-E Limitamp control. Faster than any breaker, this "all-in-one-unit" control, with its EJ-2 fuses, clears fault currents in a half cycle.

When a short occurs, the fuses cut off the rise in current in less than a quarter cycle. And the short is cleared long before the current has time to harm the contactors or motor.

GIVE YOUR STEEL PLANT THESE IMPORTANT ADVANTAGES

Completely co-ordinated control—Limitamp is "packaged" in a single unit which is easy to install and attractive in appearance.

Full protection—If voltage is low or power fails, the motor is taken off the line. And it will not restart on return of power. Accurately calibrated overload relays protect your motors from overheating due to sustained overloads or single-phasing.

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GENERAL ELECTRIC

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